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B8N

(54) Liquid delivery and accounting systems

(57) A liquid product delivery and accounting system employs a supervisory console incorporating a microcomputer, keyboard and printer, which console is electronically connected to one or more volumetric meters. In a delivery-truck embodiment, a driver connects a portable RAM card to an office computer, downloading delivery route information to the RAM card. The driver then carries the RAM card to his truck and uploads the route information from the RAM card to the console. After printing a route ticket and start-of-shift totalizer values, the driver starts on his route. Each delivery is actuated through and controlled by the console. The parameters of each delivery may be altered by keyboard entry of information by the driver into the console, although access to many items requires entry of a correct code. At the end of the delivery, the console calculates the price, tax, etc., and prints a sealed invoice for the customer. At the end of the route, an end-of-shift totalizer ticket is printed. Actual delivery information, downloaded after each delivery into the RAM card, is uploaded back to the office computer. In a truck loading-dock embodiment, a customer/driver inserts an account identification module into a dock-mounted console to allow delivery of liquid products to his truck. An invoice is printed for the driver and transactional data is communicated directly to a mainframe computer. Temperature compensation, volumetric and price presets, automatic dwell/shutoff valve control and various security features are offered.

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Fig.1.

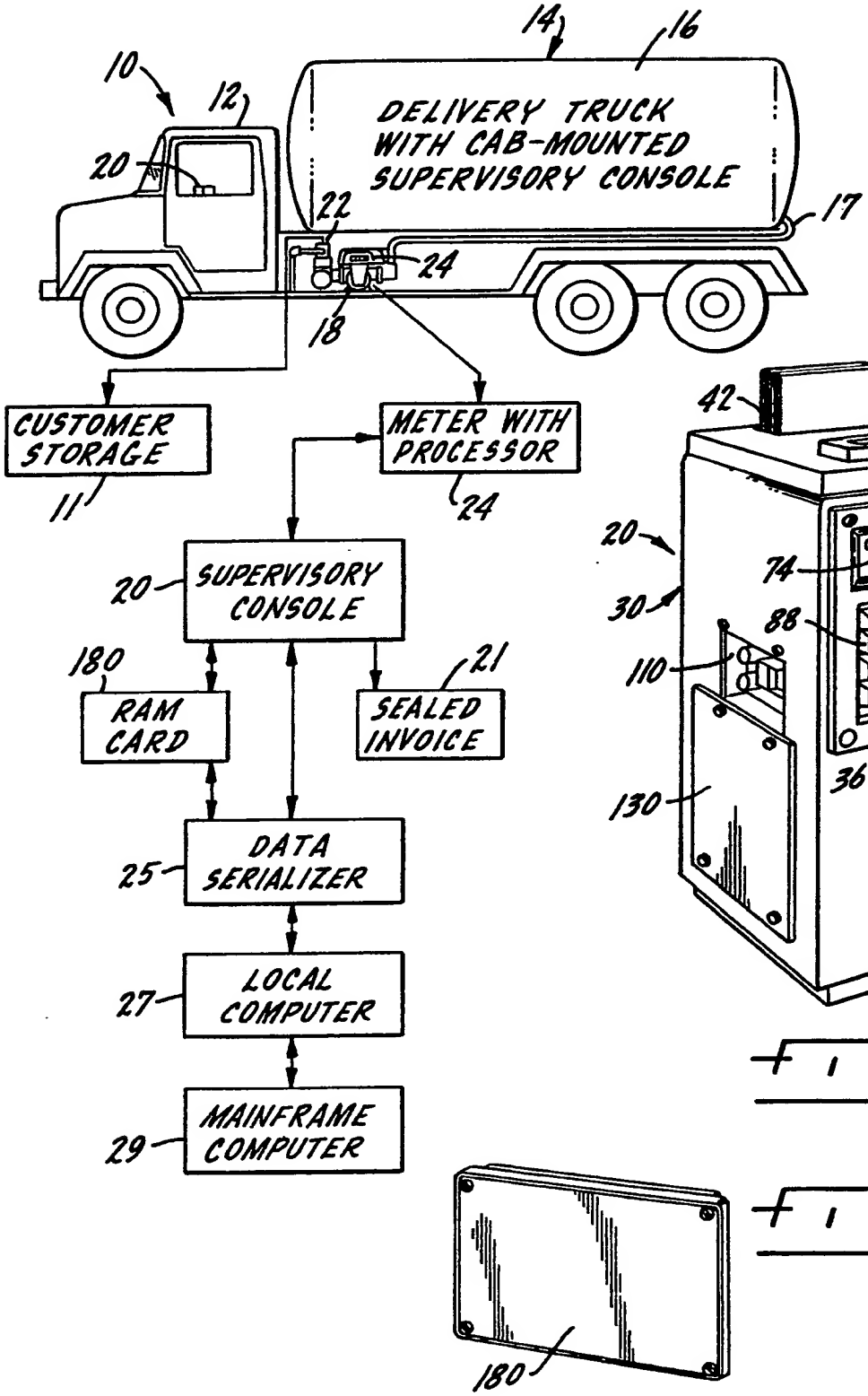

Fig.2.

Fig.9.

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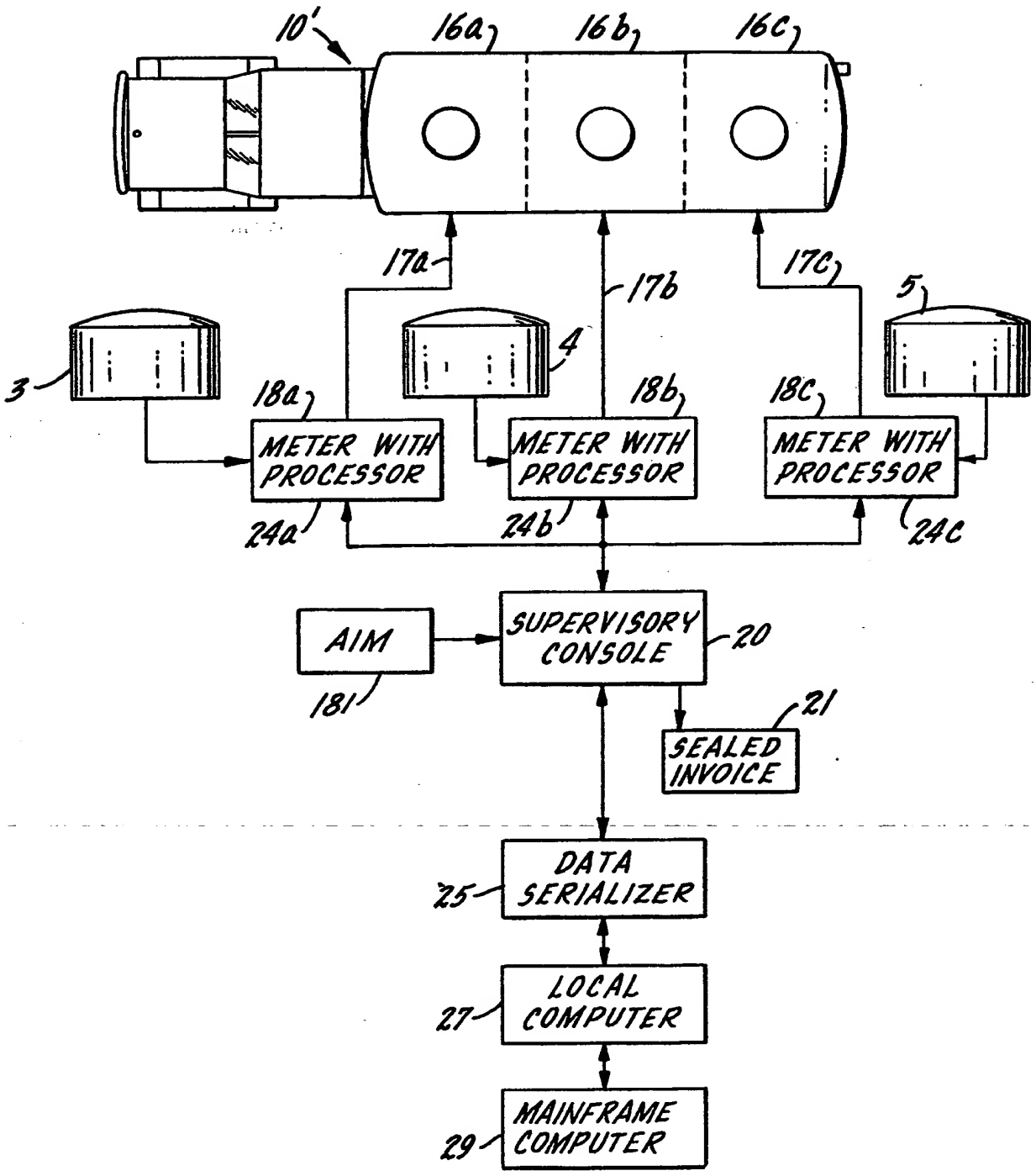

Fig. 3.

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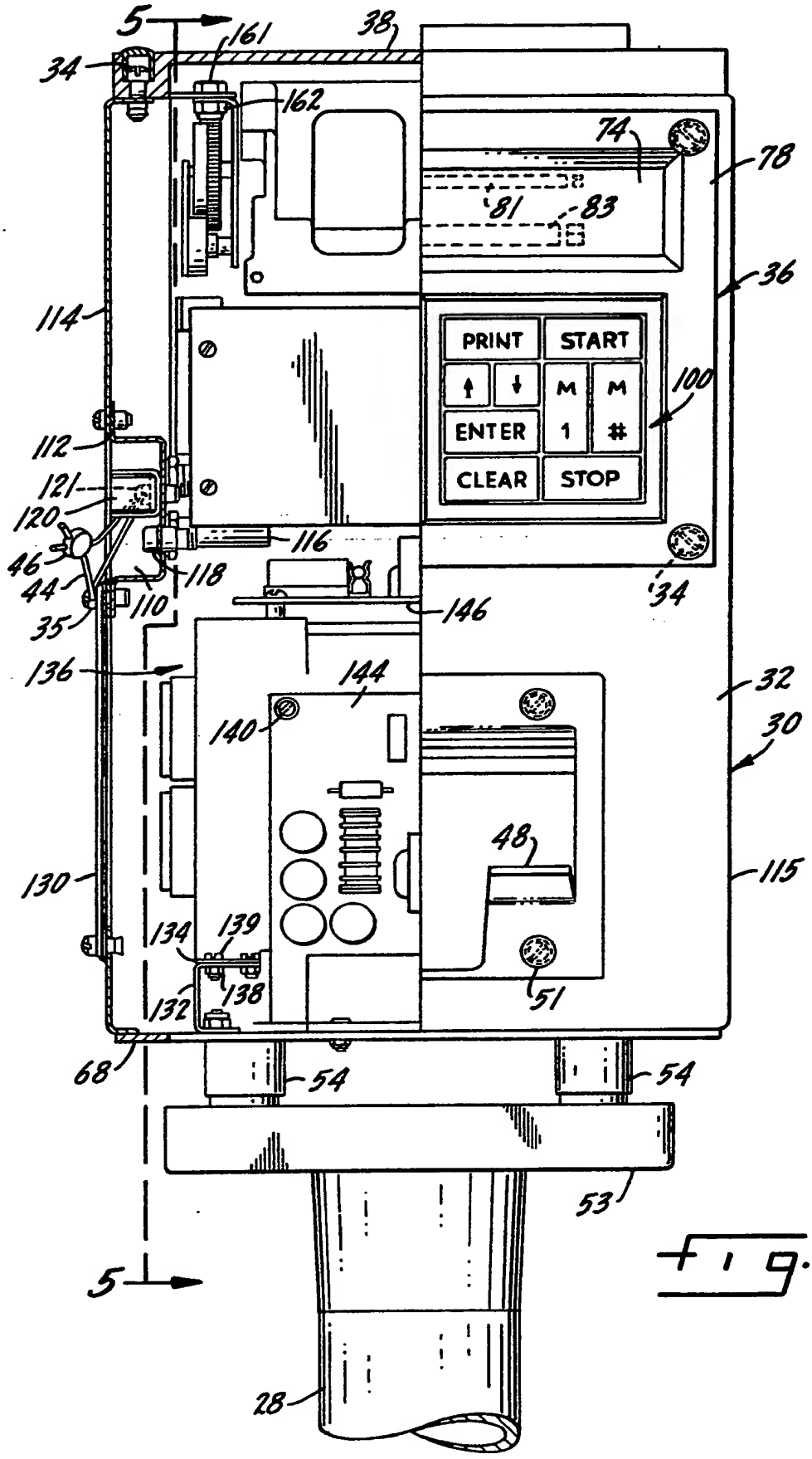

Fig. 4.

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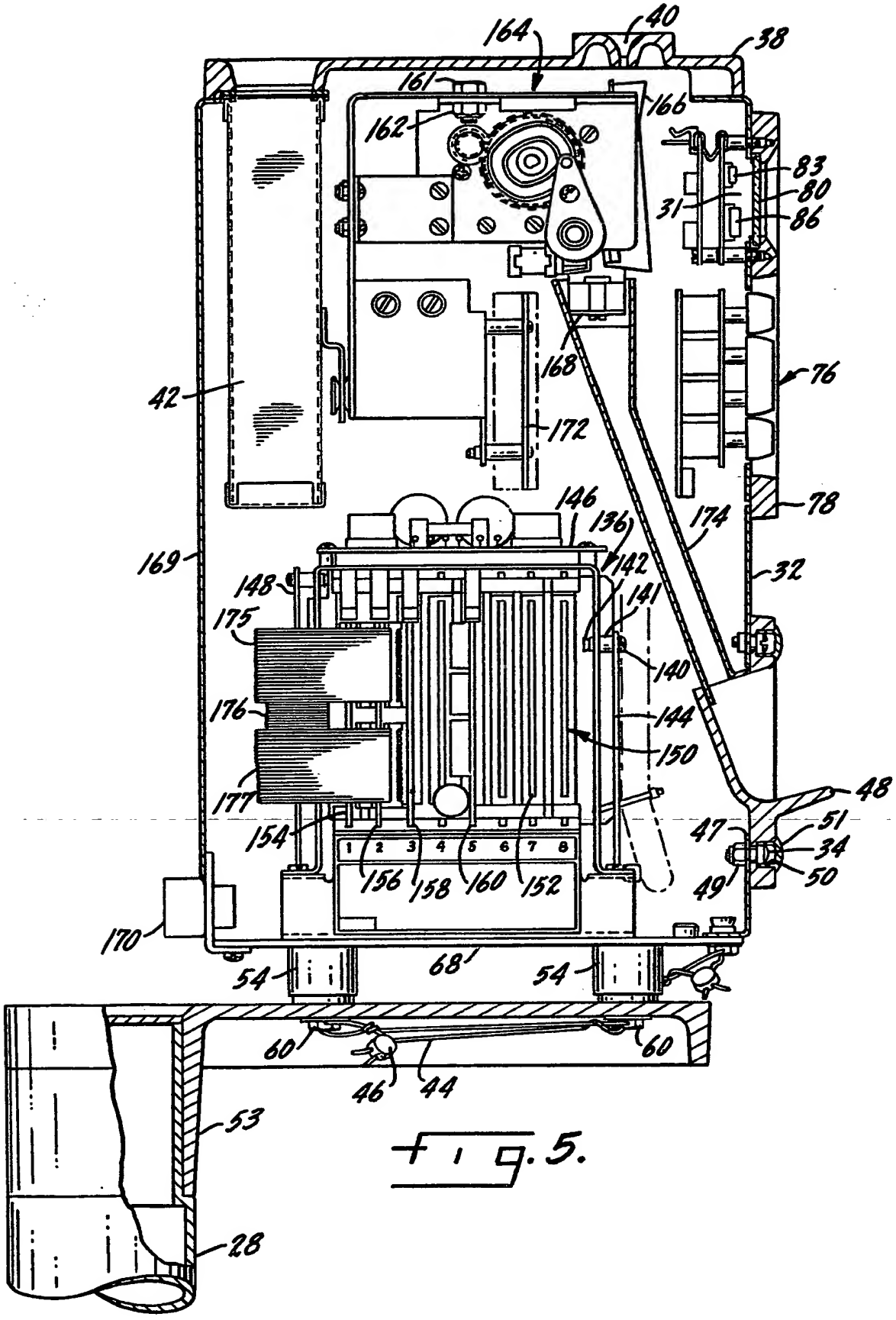

Fig. 5.

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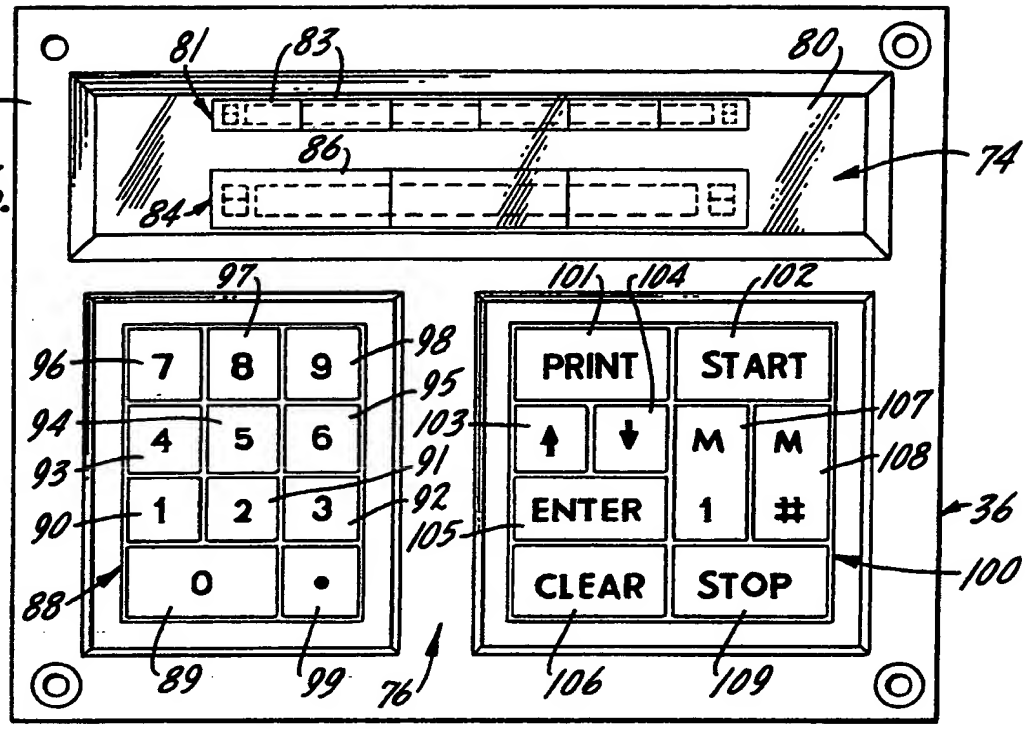

fig.6.

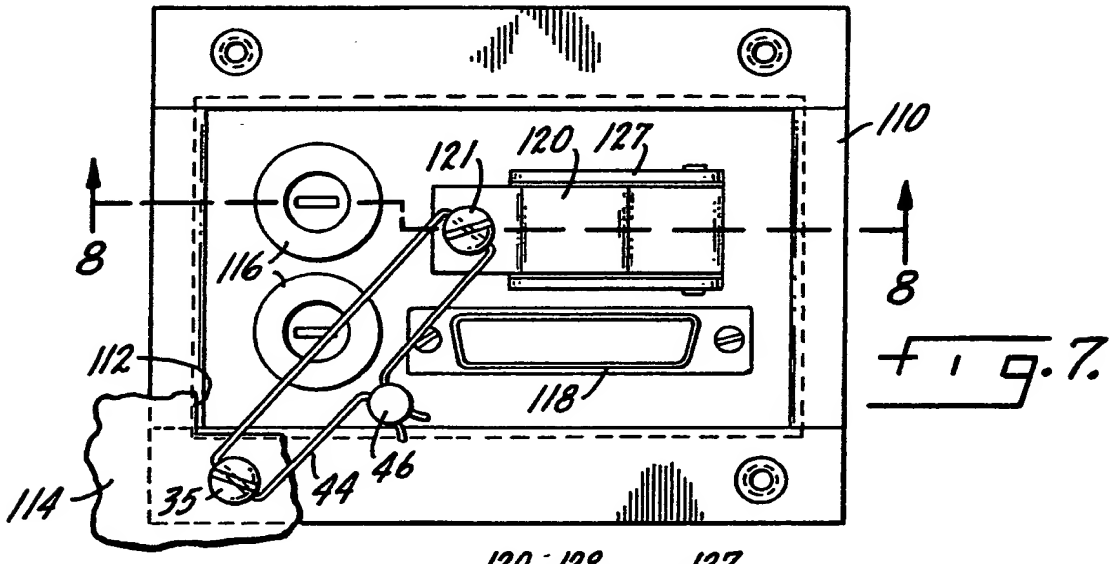

fig.7.

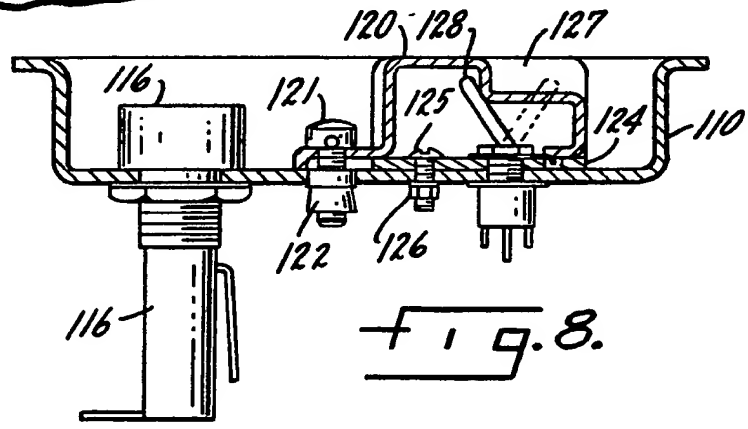

fig.8.

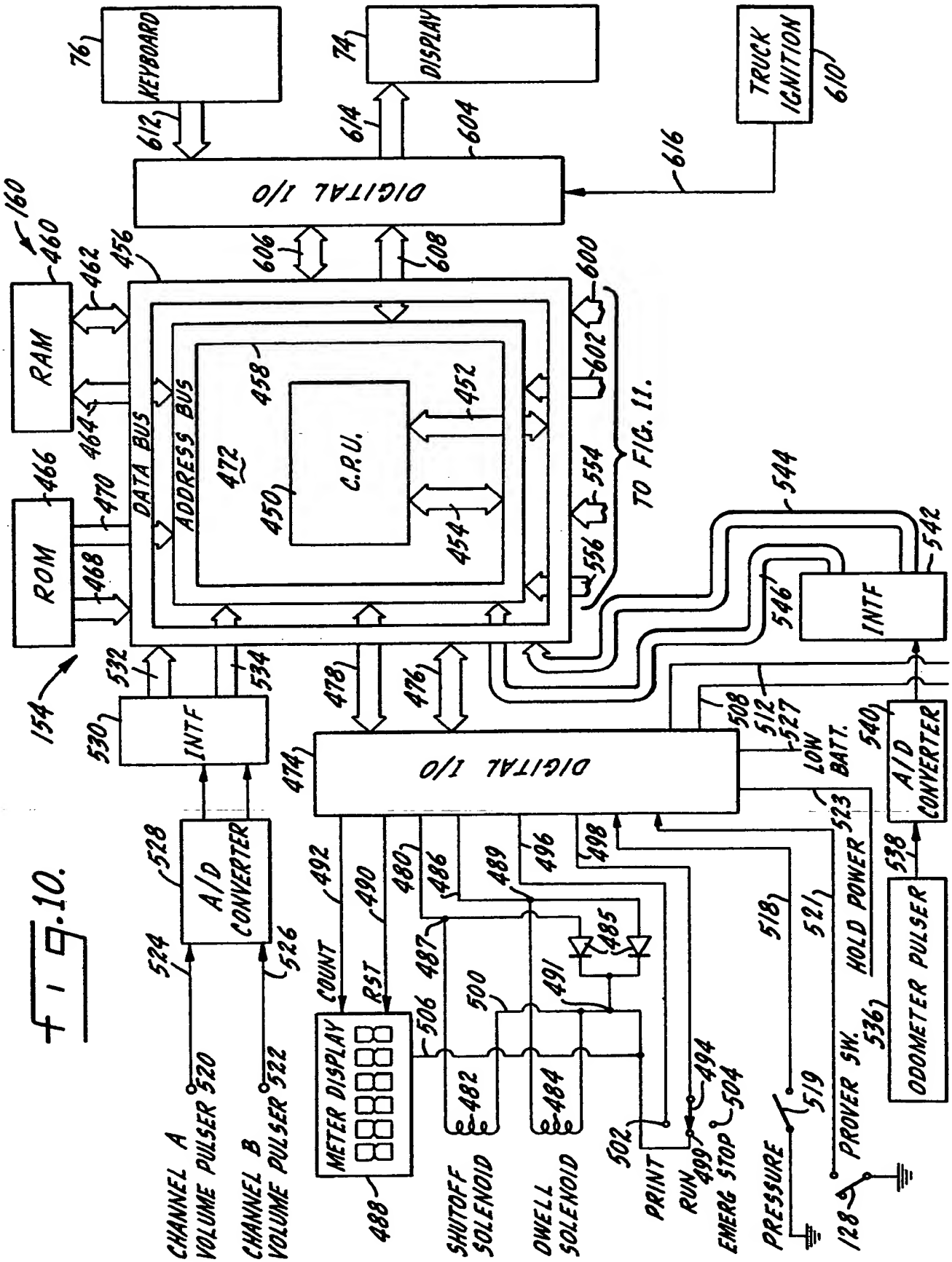
76
KEYBOARD
74
DISPLAY
TRUCK IGNITION
610
612
614
604
616
DIGITAL I/O
160
460
462
456
606
608
600
RAM
ROM
466
470
468
DATA BUS
ADDRESS BUS
472
458
452
450
C.P.U.
454
602
554
556
TO FIG. 11.
544
542
546
INTF
154
532
534
530
INTF
478
476
474
DIGITAL I/O
508
512
527
LOW BATT.
540
A/D CONVERTER
523
528
A/D CONVERTER
492
490
480
486
489
496
498
485
487
500
491
506
518
521
538
HOLD POWER
524
526
COUNT
RST
536
ODOMETER PULSER
PROVER SW.
519
CHANNEL A VOLUME PULSER 520
CHANNEL B VOLUME PULSER 522
METER DISPLAY
488
SHUTOFF SOLENOID
482
OWELL SOLENOID
484
502
PRINT
RUN
499
494
EMERG STOP
504
PRESSURE
128

FIG. 10.

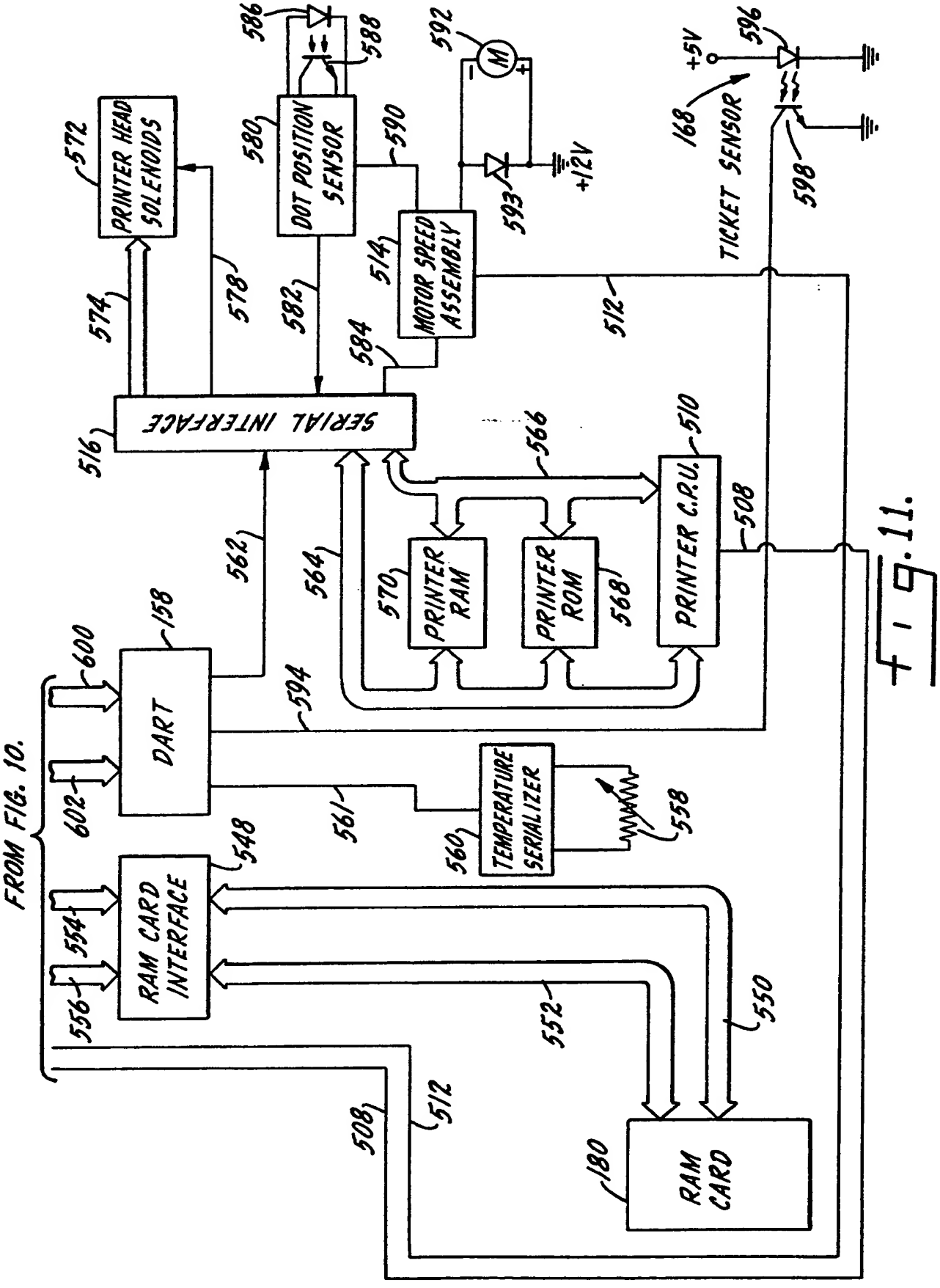
FROM FIG. 10.
DART
158
600
602
562
564
SERIAL INTERFACE
516
574
572
PRINTER HEAD SOLENOIDS
578
582
580
DOT POSITION SENSOR
586
588
584
590
MOTOR SPEED ASSEMBLY
514
592
593
+12V
512
+5V
596
168
TICKET SENSOR
598
566
PRINTER RAM
570
PRINTER ROM
568
PRINTER C.P.U.
510
508
594
561
TEMPERATURE SERIALIZER
560
558
RAM CARD INTERFACE
548
554
556
552
550
508
512
180
RAM CARD

Fig. 11.

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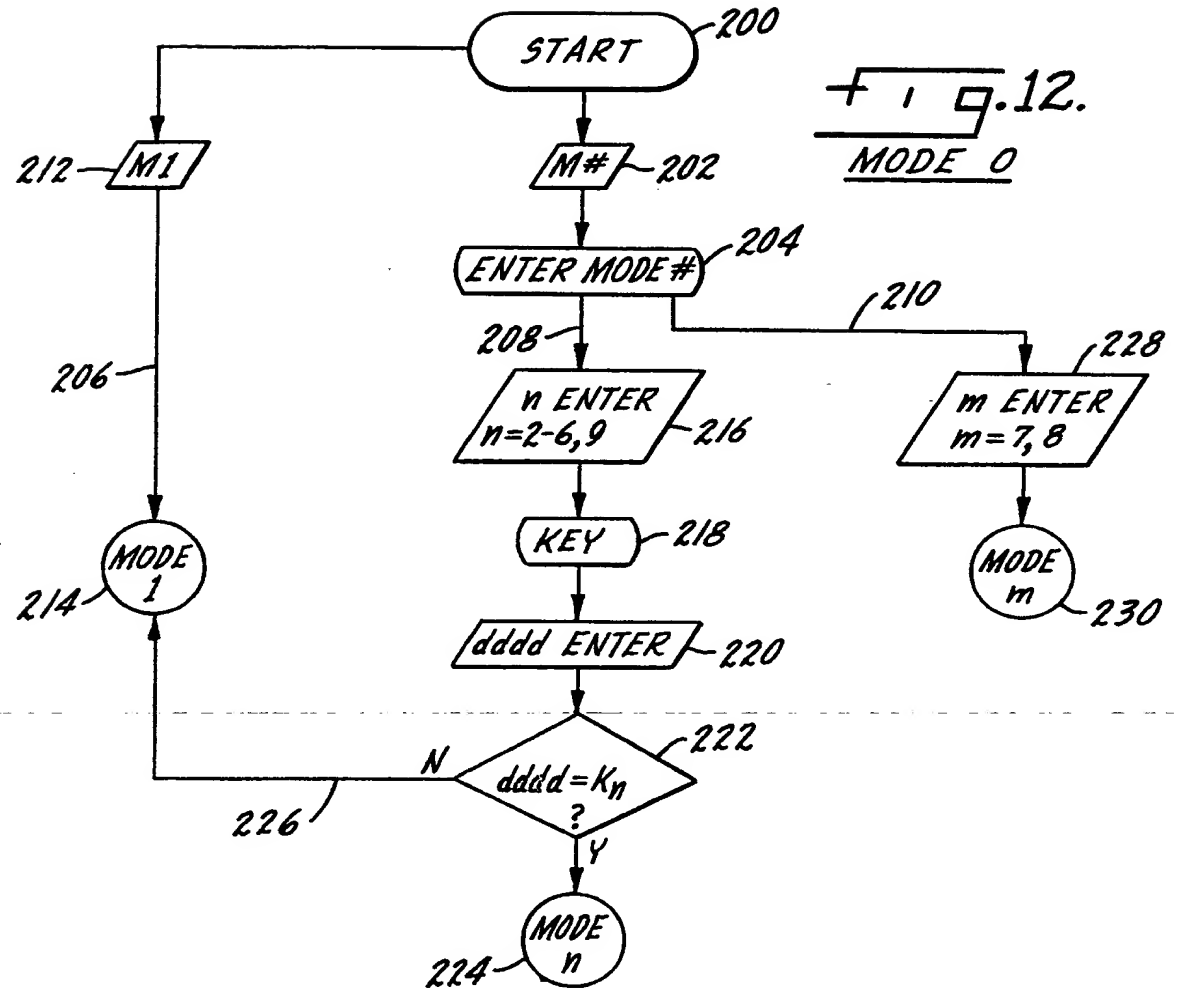

Fig.12.

MODE 0

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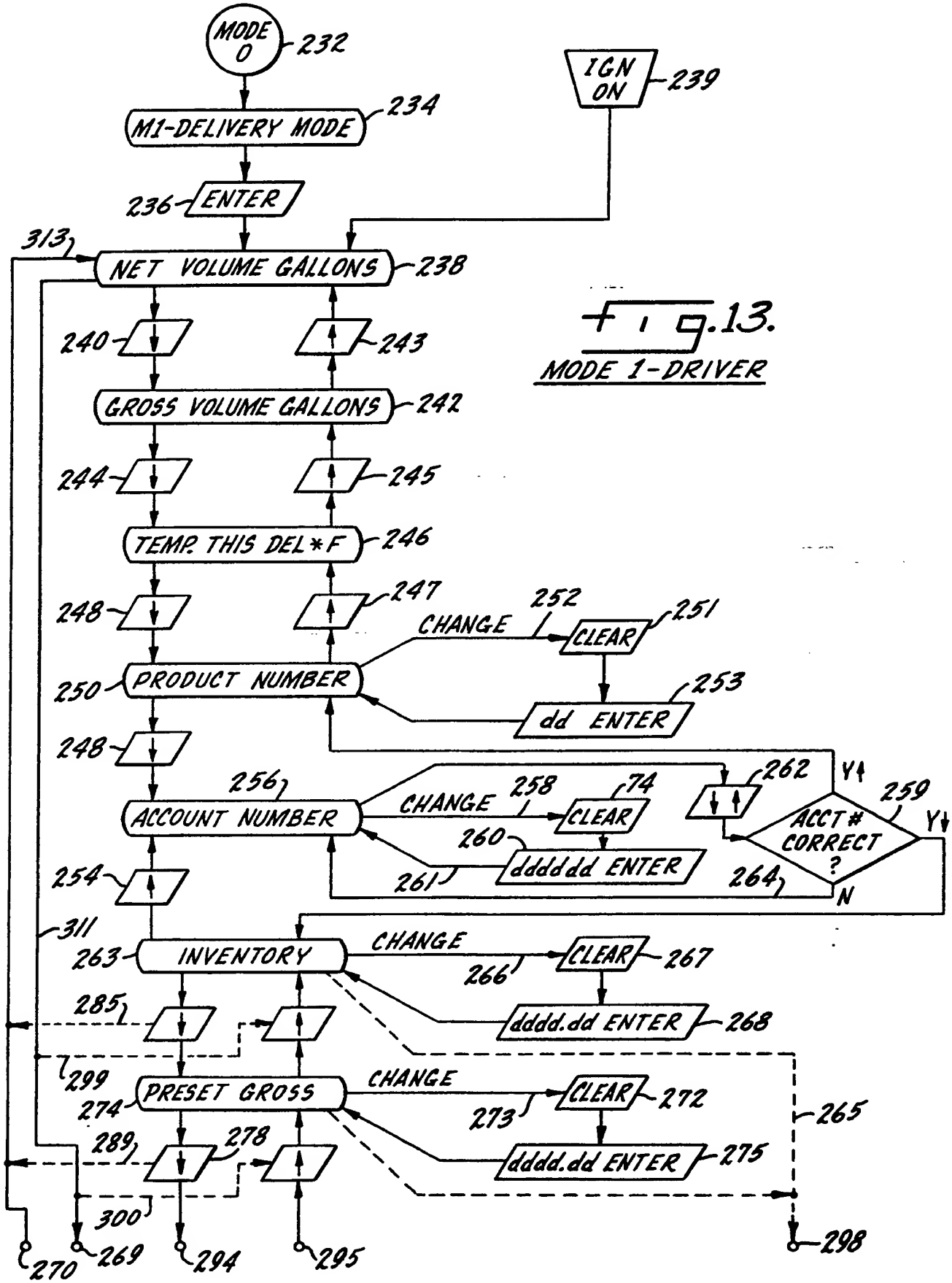

Fig. 13.

MODE 1-DRIVER

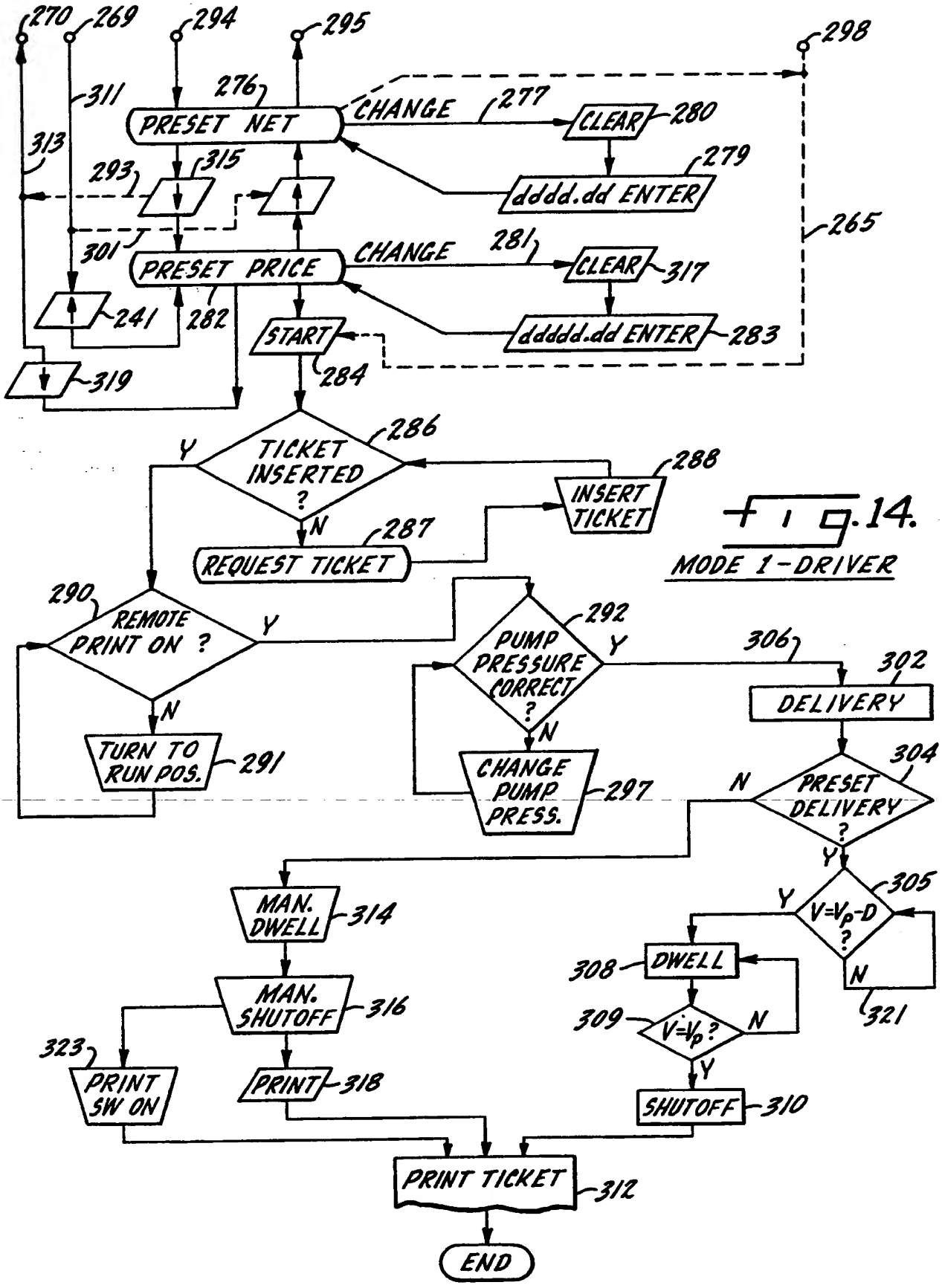

Fig. 14.

MODE 1 - DRIVER

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Fig.15.

MODE 2

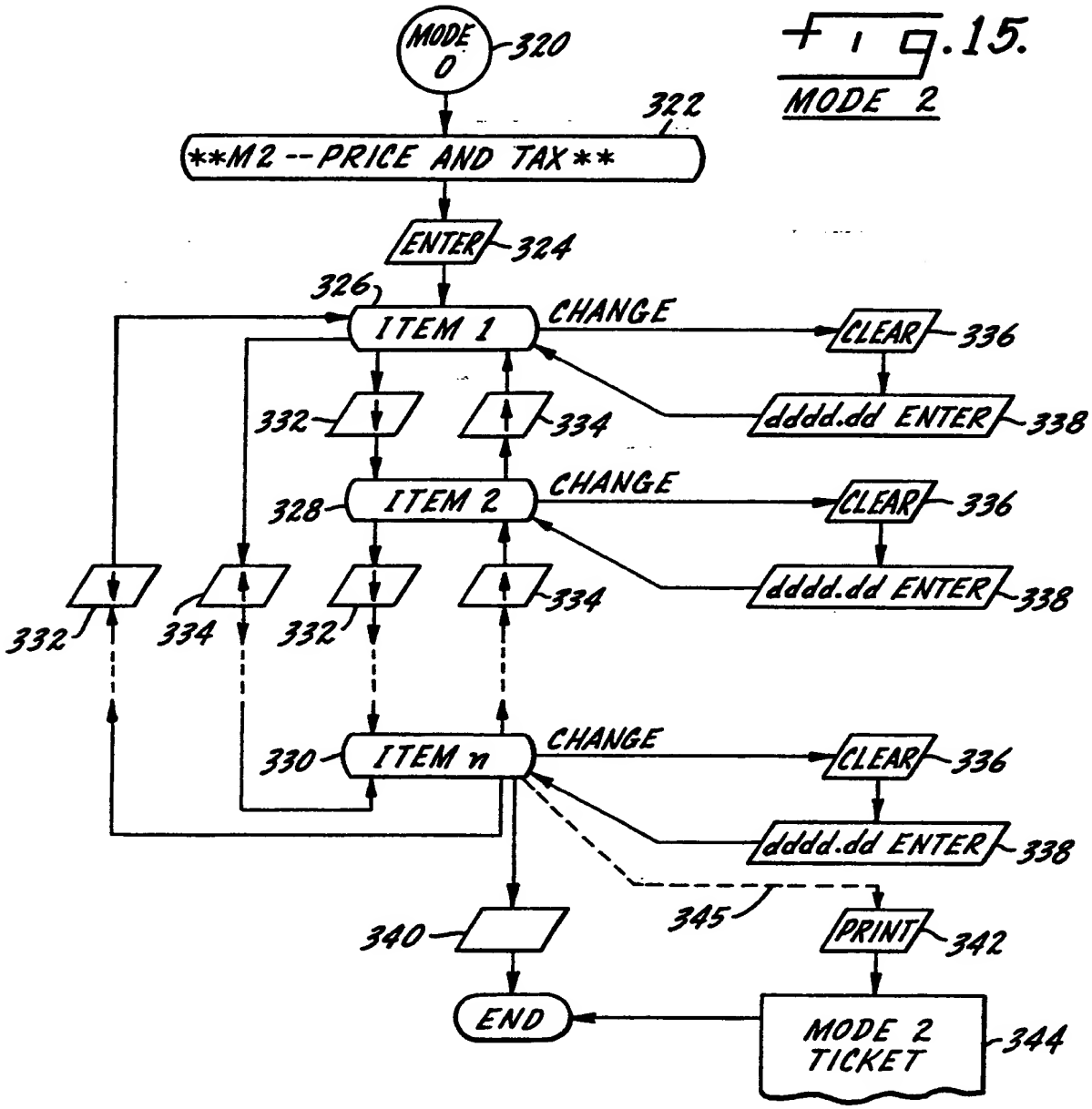

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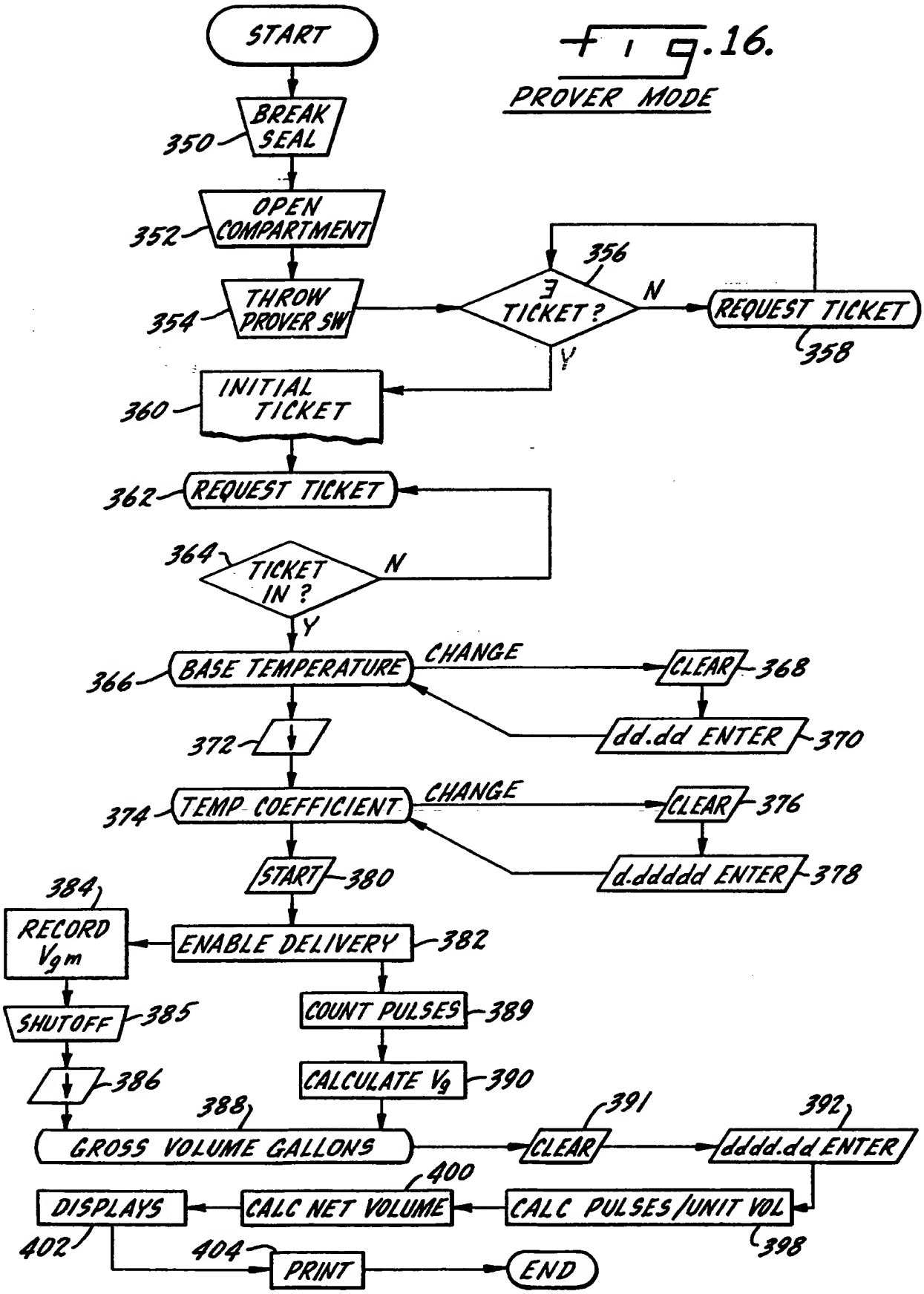
Fig. 16.

PROVER MODE



SPECIFICATION

Liquid delivery and accounting system

This invention relates to systems for liquid product delivery, and more particularly relates to liquid product delivery systems employing computing means.

Conventional liquid product delivery systems, such as either a liquid product truck making deliveries to customers on a route or a liquid product truck loading dock, consist of one or more meters measuring the product being delivered and an operator. The operator, usually a driver or dock employee, manually stops and starts delivery, manually takes down the amount of product delivered and, where a bill is issued to the customer at the time and point of delivery, manually calculates the price charged and any taxes on the transaction. After the completion of a delivery truck route or workshift, a series of such transactions are manually balanced against inventory and/or are entered into a mainframe computer by other personnel. If the bill was not issued at the point of delivery, an invoice must be separately generated and mailed after return of the delivery truck, or the customer driver must walk or drive form the loding dock to an office to get the invoice.

From the above, it can be appreciated that the conventional manual liquid product delivery system has several disadvantages and problem areas. Each manual calculation creates an opportunity for human error, as does any manual entry of information into a computer.

Calculations such as the one done for temperature compensation to an equivalent volume at a standard temperature, or calculations for commodities which require complicated price/tax formulae due to heavy governmental regulation such as fuel oil, are generally precluded from being done in the field if these must be done manually. Such computations have therefore heretofore required the separate generation and mailing of a bill to the customer from the office, adding business expenses and tending to create longer times before such bills are paid.

Further, any special customer instructions have in the past been orally or manually delivered to the driver/employee. A possibility of product delivery to the wrong customer has also always been present.

Conventional manual operations also contribute substantially to the amount of time it takes to make a single delivery. The necessary supervision by the operator of the meter during delivery has made multiple deliveries of different products at one time to a customer very difficult.

Potentially more serious than the time consumption and error caused by manual operations is the possibility of theft. A driver may steal his cargo outright, without attempting to make any recorded transaction. Alternatively, he may make out a transaction to a customer but fail to deliver all or some of the product to the customer. He may record a transaction to a spurious third party, or may tamper with the meter or mechanical totalizers to cover up the missing product. In certain situations, he may overcharge a customer and pocket the difference, or undercharge delivery to his friends.

Summary of the invention

Accordingly, it is a principal object of the invention to minimize the number of manual operations required in a liquid product delivery and accounting system, in order to in turn reduce time, expense, human error and fraud.

Another object of the invention is to automatically produce an invoice or ticket at the time and point of delivery.

Yet another object of the invention is to automatically convert a delivered product volume at ambient temperature to an equivalent product volume at a standard temperature, and issue an invoice based on the equivalent volume.

A further object of the invention is the provision of automatic volumetric or price preset limits for each customer, which limits are used to automatically stop delivery.

Another object of the invention is to provide an automatic shutoff sequence where the period and rate of dwell flow has been predetermined.

A still further object of the invention is to automatically calculate the price and tax on the delivered product at the point of delivery.

A further object of the invention is to provide an easy and automatic method of meter proving, i.e., measurment constant calibration.

Yet a further object of the invention is to automatically totalize all transactions, and communciate these with other transactional data to a main computer without intervening manual operations.

A further object of the invention is to automatically record the date and time of each liquid product delivery.

Another object of the invention is to provide for the automatic delivery of several different liquid products at one time.

These and other objects of the invention have been met by the provision of a fluid delivery system using a supervisory console, one or more meters with dedicated processors, an RAM card or account identification module and a main base computer.

The supervisory console incorporates a microcomputer, a ticket or invoice printer, numeric and function keyboards, a display, and connection to the dedicated processor(s), other peripherals if mounted in a vehicle and a data access port to a RAM card or account identification module (AIM). The microcomputer or CPU receives data from one or more volumetric meters, associated temperature probes and pressure switches, and in one embodiment also receives signals from the delivery truck ignition and odometer. The microcomputer controls the display and printer as well as the dwell and shutoff functions of the meter valve(s).

In the delivery truck embodiments, according to the invention the driver will first connect a portable RAM card to a mainframe or office computer, which will then download delivery route data to the RAM card. The driver then goes to his loaded delivery truck and uploads the delivery route data to the CPU memory by connecting the RAM card to the appropriate console data port. The delivery route data typically includes customer names, addresses, account numbers, price and tax rates, any customer volume or price delivery limits, loaded inventory and any special instructions. The CPU may then optionally print out a delivery schedule and/or a pre-shift totalizer ticket, the pre-shift ticket showing totals and other data for each product handled by the console.

The driver will then drive to the first of a series of delivery locations, enter a correct customer account number, and insert a ticket or invoice into the printer. The CPU disables delivery if these last two actions are not taken. The driver may then add or change delivery data stored in the CPU memory by means of the function and numeric keypads. Some information may be accessed/altered freely, but other information requires the entry by the driver of a correct numeric access code. The driver then connects up delivery lines to the one or more delivery valves and customer delivery points, and starts delivery at the console.

The console's CPU will then count and sum pulses fed it from the meter-dedicated processor(s), each pulse representing a volumetric increment. Where temperature compensation is desired, the CPU will also record temperature serial data from each meter temperature probe.

Where any of three volume or price presets has been entered either manually or by way of the RAM card, the CPU will periodically compare the preset to the volume delivered so far. Upon approaching the preset limit, the CPU will close the valve to a dwell condition and after a predetermined period will shut it off completely. Where no presets have been entered, delivery is manually terminated.

After calculating total volume, correction for temperature, price, tax and other items, the console prints an invoice for the customer. The transactional data and CPU-incremented totalizer data is then fed to the RAM card. Such transactional data may include odometer readings before and after each delivery, to make sure that the truck hasn't moved (and product hasn't been delivered to a non-billed party) during delivery.

These steps are repeated for each delivery. At the end of the route, the console is operated to print an after-route or after-shift ticket, and the RAM card is connected back to the office computer to transmit transactional data to the mainframe.

In an alternate embodiment, the invention is used in connection with loading liquid products from a fixed location such as a loading dock to a vehicle such as a multi-compartment tank truck. The console and meter(s) are in this embodiment located on the dock and the console may be in direct communication with an office computer or mainframe.

In the loading dock embodiment, the operator of the tank truck uses an account identification module (AIM) to gain access to the console. The AIM needs much less memory capacity than a RAM card, as data for only one customer needs to be supplied and the AIM does not have to function as a transactional data transfer device. After gaining access to the console, the driver inserts a ticket into the console, connects the delivery lines, and starts delivery. The meter and console functions are similar to their functions in the delivery truck embodiment for the measurement, preset, shutoff, calculation, totalizing and ticket-printing steps.

In either embodiment, the invention thus reduces the time, error, expense and potential for theft associated with conventional, manually-operated delivery systems. In the delivery-truck embodiment, the driver can produce a sealed invoice for the customer at the point and time of delivery. In the loading-dock embodiment, the customer or customer's employee receives such an invoice without the involvement of the distributor's personnel. The expenses of separately preparing and mailing an invoice are in either case avoided and payment is speeded up.

By having the console automatically calculate prices and taxes of delivered products, the time and error associated with manual entry or calculation are greatly reduced or eliminated. Further, since the console produces a totalizer ticket at the beginning and/or end of each shift, it is no longer necessary to manually balance the days' transactions ticket-by-ticket. Finally, the direct posting of all daily transactions from the RAM card or console to the office computer or mainframe eliminates the labor costs and error associated with manual posting.

Brief description of the drawings

The attention of the reader is now directed to the drawings, wherein

Figure 1 is a schematic diagram showing the method of the invention as employed in a delivery-truck embodiment;

Figure 2 is a perspective view of the supervisory console employed by the invention;

Figure 3 is a schematic diagram showing the method of the invention as employed in a truck-loading system;

Figure 4 is a front elevation of the supervisory console with one-half shown in section;

Figure 5 is a side elevational section taken substantially along line 5-5 of Figure 4;

Figure 6 is a detail of the keyboard and display of the supervisory console;

Figure 7 is a detail of the power switch, fuse and data port panel of the supervisory console;

Figure 8 is a sectional view taken substantially along line 8-8 of Figure 7;

Figure 9 is a perspective view of the RAM card used with one embodiment of the invention;

Figure 10 is an electronic block diagram of the supervisory console and peripherals;

Figure 11 is a continuation of Figure 10;

Figure 12 is a user flowchart showing an access sequence to the various use modes of the supervisory console;

Figure 13 is a user flowchart for use of the supervisory console in Mode 1;

Figure 14 is a continuation of Figure 13;

Figure 15 is a user flowchart for use of the supervisory console in Mode 2;

Figure 16 is a user flowchart for use of the supervisory console in the Prover Mode;

Detailed description of preferred embodiments

Mode of operation

Referring to Figure 1, there is shown one possible liquid product delivery system employing the method of the present invention. Truck 10 has a cab 12 and a liquid tank 14, which may be divided into one or more product compartments 16, although only one compartment is shown in Figure 1. Associated with each compartment 16 is at least one pipe 17 leading from compartment 16 to measuring meter 18, in a preferred embodiment an explosion-proof turbine meter. Turbine meter 18 may be located behind cab 12 as shown, or it may be located at any other convenient location outside of the cab such as at the rear of tank 14. Turbine meter 18 has an outlet 22 for the delivery of measured liquid product to the customer, and is equipped with meter-dedicated processor 24. Processor 24 is electronically connected in a manner later described to supervisory console 20 (better seen in Figure 2) mounted inside of cab 12 in a position convenient to the driver/operator.

The embodiment shown in Figure 1 is designed for the delivery and accounting of liquid products as they are delivered to one or more customers on a delivery route by truck 10. As liquid product flows through line 17 to e.g. customer storage tank 11, the liquid product is metered by turbine meter 18, whose mechanical movements are translated into electrical pulses by meter-dedicated processor 24. These pulses are electrically fed to supervisory console 20 (Figure 2). After making the calculations hereinafter described, console 20, which incorporates a printer assembly 164 (Figure 5), prints a sealed invoice or ticket 21 from one of the stored blank tickets 23 (Figure 2).

Simultaneously, this information is electronically transferred to RAM card 180, a portable memory capsule which prior to the start of the delivery route had transferred customer information (name, address, account number, applicable product codes, prices tax rates and price or volume presets) for each customer on the route to the memory of console 20.

At the beginning of each series of deliveries, a ticket may be printed showing loaded inventory and the delivery route. At the completion of the delivery route, RAM card 180 contains a complete record of all deliveries made, some or all of which data may be printed by console 20 on an end-of-shift ticket. RAM card 180 transfers its stored delivery data via data serializer 25 to a local computer 27, which records the day's transactions on a medium such as a floppy disk for later transcription to mainframe computer 29.

Figure 3 shows an embodiment of the present invention designed for a liquid product truck loading system. Truck 10, having separate liquid product tank compartments 16a, 16b and 16c, is backed up to a loading dock and lines 17a, 17b and 17c are connected to valves associated with meters 18a, 18b and 18c. Liquid product is supplied to the meters from storage sources 3, 4 and 5. Also on the loading dock is supervisory console 20, into which the operator inserts his account identification module (AIM) 181. AIM 181 is typically smaller and has less memory capacity than RAM card 180, as it generally carries only information about the driver or his firm: customer ID, driver ID, credit limit, price per unit measure for different products, preset volume or price limits for each product, etc. RAM card 180, on the other hand, must have sufficient memory to contain all of this information for each customer on a delivery route, or sufficient memory to record actual delivery information for each customer on the route.

After access has been acknowledged by supervisory console 20, the driver inserts a ticket into console 20, makes any allowable delivery presets in terms of volume or price, and initiates loading. Meters 18a, 18b and 18c and dedicated processors 24a, 24b and 24c volumetrically measure the products as they are being delivered, preferably monitor the products' temperatures, and feed this information to console 20. After delivery is stopped, either manually or automatically by means of a preset previously entered into console 20, console 20 will print out a ticket or sealed invoice 21, containing the customer's name, address, and account number, and stating the volume of each product loaded (optionally corrected for temperature) and the price for each product. The transactional information is transmitted via data serializer 25 to local disk-based computer 27, where it is stored for polling by and uploading to mainframe computer 29.

The embodiment as shown in Figure 3 may also be altered for use in aircraft refueling. In this alternative, non-illustrated embodiment, account identification module (AIM) 181 would be provided with a "load" function for downloading identification data from an aircraft data terminal and a "transfer" function for uploading this information to console 20.

Where the aircraft are refueled from an underground hydrant through a vehicle incorporating a refueling valve, a fuel line and a supervisory console 20, AIM 181 would first be connected to a data terminal on the aircraft by the operator of the vehicle. Data identifying the aircraft and required fuel grade would be transferred from aircraft memory means to AIM 181 when AIM 181 is operated in "load" mode. The operator would then disconnect AIM 181 from the aircraft, carry the module over to console 20, connect module 181 to console 20 and transfer the aircraft identification data to console 20 by operating AIM 181 in the "transfer" mode. After console 20 acknowledges access, loading would be done in a manner similar to that described in Figure 3.

Other variations on the above liquid product delivery schemes may easily be thought of, and the described embodiments are for purposes of illustration only.

Mechanical elements

Figures 4 and 5 show supervisory console 20 in more detail as mounted on pedestal 28. The components of console 20 are supported and contained by a case 30, preferably constructed of welded metal plates and treated as appropriate to prevent corrosion. Mounted into upper opening 31 in front panel 32 as by means such as machine screws 34 is display and keyboard assembly 36.

As can be seen from Figure 2, the tickets to be printed are inserted through top panel 38 by means of a preferably cast ticket slot 40. Blank tickets are stored in ticket storage bin 42. Cover 38 is preferably mounted to case 30 as by machine screws 34, one or more of which may have a drilled head with a cable passing through it, which cable is brought through another fixed point and sealed with a lead seal to prevent undisclosed tampering with the contents of case 30.

Front panel 32 also is formed with lower opening 47, into which is installed ticket chute cover plate 48. Chute cover plate 48 is mounted by means such as machine screws 34 and nuts 49 to front panel 32. The machine screws 34 are received within counterbores 50 (Figure 5) and fitted with protective caps 51.

Case 30 is mounted to swivel assembly 53 of pedestal 28 by means of spacers 54 and drilled machine screws 60. These may not be unscrewed from assembly 53 without breaking lead seal 46, as they are attached to each other through cable 44.

Display assembly 74 is attached to the interior wall of front panel 32 at a point above keyboard assembly 76, both of which are covered by display and keyboard bezel 78. Display assembly 74 is in addition covered by transparent lens 80. In this embodiment, the display elements of display assembly 74 consist of two rows of dot-matrix LED units 83 and 86.

Figure 6 more particularly shows the layout of display and keyboard assembly 36. Top row 81 consists of six alphanumeric display chips 83, each of which has four dot matrices. Top row 81 thus can display a total of twenty-four characters. Bottom row 84 consists of three alphanumeric display chips 86, each of which has four 5 × 7 dot matrices. Bottom row 84 is thus capable of displaying twelve alphanumeric characters which are however of larger size. In use, top row 81 generally displays alpha characters and bottom row 84 displays numbers. Variations on the described embodiment can easily be though of in terms of type of dipslay (LED, liquid crystal or CRT), number of chips and characters, and placement of display elements.

Keyboard assembly 76 has in this embodiment two keypads: a numeric keypad 88 containing number keys 89-98 and a decimal point key 99, and a function keypad 100. Function keypad 100 has a PRINT key 101, a START key 102, an upscroll key 103, a downscroll key 104, an ENTER key 105, a CLEAR key 106, a Mode 1 key 107, a Mode *n* key 108, and a STOP key 109. The functions of these keys will be later described. Other embodiments of the present invention may have a different or expanded set of function keys, and the arrangement of function keys in Figure 6 can obviously be varied as well.

Returning to Figure 4, there is also shown a prover switch connector and fuse panel 110 recessed within opening 112 of left case panel 114. Panel 110 is shown in more detail in Figures 7 and 8. Mounted on panel 110 are a pair of fuses 116, a multiple pin connector 118* and switch seal plate 120. Switch seal plate 120 is affixed to panel 110 by means of drilled machine screw 121 and nutsert 122. In between switch seal plate 120 and fuse panel 110 is plate 124, itself attached to fuse panel 110 by means of screw 125 and nut 126 and forming the sides 127 of the prover switch seal. Inside switch seal plate 120 is prover switch 128, shown in the "disable" position. The shape of switch seal 120 is such that prover switch 128 cannot be moved to the "enable" position (shown in phantom) without removal of switch seal 120. Since drilled machine screw 121

has cable 44 passing through it, which cable is connected to another close-by point such as the head of drilled machine screw 35, and since the ends of cable 44 are brought together and sealed with a bureau of standards seal 46, switch seal 120 may not be removed without showing evidence of tampering.

Returning to Figure 4, side cover 130 is secured as by machine screws 34, which may be drilled and cabled in a manner similar to that shown for panel 110.

Figure 5 shows the internal layout of console 20, with wiring and other parts having been omitted for clarity. Supported by base plate 68 through left cage foot 132 and a right cage foot (not shown) is CPU assembly 136. Left cage foot 132 is secured to base plate 68 and left cage suppport 134 by locknuts 138 and machine screws 139 (Figure 4). Not shown is a right cage support similar to left cage support 134 and affixed in a similar manner to the right cage foot.

Four panels are affixed as by screws 140, spacers 141 and nutserts 142 to the left and right cage supports: a power supply assembly board 144 (best seen in Figure 4), a power kludge board 146, a signal kludge board assembly 148 (only the board is shown in Figure 5) and a backplane (not shown) on the side nearest to right case panel 115. Affixed to the interior of the cage supports is a circuit board guide and spacer assembly 150, shown in this embodiment with eight circuit board slots 152. Interior circuit boards 154, 156, 158 and 160 are slid into four of the eight slots and into a series of multiple pin connectors (not shown) mounted on the backplane. In this embodiment, interior board 154 is the CPU and ROM board containing an eight-bit microprocessor chip; board 156 is a data input/output board; board 158 is a digital/asynchronous receiver/transmitter (DART) board for receipt and transmission of RS232 serial data to printer assembly 164 and dedicated processor 24; and board 160 is a 6K RAM board. The extra card slots 152 are provided for additional boards such as an optional RAM board for additional read/write capability (not shown). Ribbon cables 175, 176 and 177 connect DART board 158 with signal kludge board 148. Inserted through the extreme lower end of rear panel 169 is main connector 170, the cables from which connect CPU assembly 136 through the interior of pedestal 28 to various truck systems, including an electrically pulsing odometer, the ignition, 12V DC power from the truck battery and dedicated processor 24.

Affixed to left panel 114 and right panel 115 as by machine screws 161 and locknuts 162 (one of each shown in Figure 4) is printer assembly 164.

Printer assembly 164 consists of a ticket tray 166 into which a blank ticket is inserted upside down for printing*, means to securely hold the ticket in place while each line is printed, a plurality of solenoide-actuated dot-matrix printing heads (not shown), a printer motor to advance the ticket line by line after the preceding line is printed, and an optical ticket sensor 168. The mechanical details of printer assembly 164 are not central to the invention and as such will not be set out here. Suffice it to say that alphanumeric information for printing is electronically transmitted to printer control board 172, which in turn controls the printer heads and advance mechanism. Optical ticket sensor 168 senses the presence or absence of an inserted ticket. After a ticket 21 is printed, it falls down chute 174 and becomes visible in chute cover plate 48 as in Figure 2, where an operator may conveniently pull it out of the console.

Adapted to be inserted into multiple pin connector 118 is RAM card 180, one embodiment of which is shown in Figure 9. As previously discussed, RAM card 180 is designed to transfer information from a local or mainframe computer to console 20, and vice versa. To effect these information transfers, 16K of RAM has been found to be sufficient, using common 8-bit digital architecture and input/output. In addition to memory, control and input/output interface integrated chips, RAM card 180 also carries a power supply such as a small battery to keep the volatile memory contents alive. Since the internal structure of RAM card 180 is not important to an understanding of the present invention, it will not be further described here.

In the loading-dock embodiment of the present invention, an account identification module (AIM) may be used in place of a RAM card. The AIM need only contain about 2K of random access memory to effect its functions as part of a vehicle-loading scheme.

Electronic elements

Having described a mechanical embodiment of the present invention, the reader is next directed to Figures 10 and 11, which are electronic schematic/block diagrams showing the CPU assembly, I/O devices and peripherals both inside and outside of console 20.

Central to the electronics of the present invention is central processing unit (CPU) block 450, physically located on CPU/ROM board 154. CPU block 450 contains a microprocessor unit such as a Z80 integrated microprocessor chip and associated interface elements. CPU block 450 and the other elements of the microcomputer are based preferably on 8-bit architecture. Paths 452 and 454 show two-way connections between CPU block 450, data bus 456, and address bus 458. The reader should assume the existence of bus drivers, control lines, clock lines and power lines, which for purposes of clarity have been omitted throughout.

Located on card 160 is random access memory (RAM) block 460, actually a series of RAM integrated chips and associated interface chips. Paths 462, 464 access CPU data bus 456 and address bus 458, respectively. Read-only memory (ROM) block 466 is connected similarly to data bus 456 and address bus 458 via paths 468 and 470.

CPU block 450, RAM block 460, ROM block 466, data bus 456 and address bus 458 together comprise CPU unit 472, which is programmed to carry out the various tabulations and computations of data herein described. CPU unit 472 has several input/output ports, among them digital interface block 474, connected via data and address paths 476 and 478.

Interface block 474 mainly handles I/O lines from dedicated processor 24. Several of these deal with the fluid valve associated with turbine meter 18, which valve has pump, dwell and shutoff positions. Line 480 is switched to receive a signal to shutoff solenoid 482 when the valve is desired to be opened. Dwell solenoid 484 is connected via line 486 to interface block 474; switching line 486 closed while switch 494 is in RUN position 499 and while signal line 498 is high causes the valve to close almost but not completely all of the way in order to avoid fluid hammer at the end of a fluid delivery.

Dedicated processor 24 may optionally have an LED meter display 488 and associated logic, in which case the display is controlled by COUNT line 490 and RESET line 492. Interface block 474 also sends a RUN signal to 3-way meter switch 494 via line 498. In its RUN position 499, switch 494 is connected via line 500 to dwell solenoid 484 and shutoff solenoid 482, allowing the valve to fully open if lines 480 and 486 are switched closed by block 474. In PRINT position 502, switch 494 allows the valve to close and sends a signal to interface block 474 via line 496 to instruct console 20 to print the ticket produced at the end of each delivery. Switch 494 may also be turned to its EMERGENCY STOP position 504, which closes the valve by opening the circuits for solenoids 482 and 484. A ticket will not be printed when the switch is in EMERGENCY STOP position 504. Optionally, RUN switch position 499 may also activate a reel-heating function through line 506, the electronics for which are associated with meter display 488. Over-voltage diode pair 485 is connected across dwell and shutoff solenoids 484, 482 at 487, 489, 491.

Interface block 474 also receives PRINTER DISABLE line 508 from printer CPU block 510 (Figure 11), whereby a command may be sent to disable printer 164 while fluid is being pumped through the valve (i.e., shutoff solenoid 482 is energized). It also handles ticket jam line 512, whereby a signal is transmitted from printer motor speed assembly 514 (Figure 11) when a ticket is jammed in the printer mechanism. A high signal on this line will prevent serial data from being transmitted by digital asynchronous receiver/transmitter (DART) 158 to printer serial interface block 516.

Also received by interface block 474 is meter pressure signal line 518, which transmits a high signal when switch 519 is open due to abnormal fluid pressure, causing fluid delivery to be interrupted. Line 512 is connected to prover switch 128. A low condition on this line is needed before the prover mode of the console may be entered, as discussed below. Finally, digital interface block 474 also handles HOLD POWER line 523 and LOW BATTERY line 527. Line 524 transmits a signal indicating below-normal voltage in the truck battery.

Figure 10 shows an electronics block diagram for one meter only. However, two or more meters may be employed, one for each product or tank. In this case meter display count line 490, display reset line 492, shutoff line 480, and meter pressure line 518 are all duplicated for each additional meter, and the interface capability of interface block 474 is commensurately expanded.

The liquid product volume passing through meter 18 is mechanically measured as by the rotation of a shaft, and this motion is translated into two channels of electrical pulses by volume pulsers 520 and 522. Various means of generating electrical pulses from mechanical motion are known in the art, including means such as the magnetic coupling of magnets and one or more Hall-effect transistors. Any suitable pulse generating means may be employed in the present invention.

Channel A and channel B pulses, resulting from a small measured increment of fluid passing through meter 18, are fed via lines 524, 526 to analog/digital converter unit 528, and from thence to pulser interface block 530. Interface block 530 has data and address connections 532, 534 to data and address buses 456, 458. For each additional meter, the above-described pulse electronics are duplicated.

In the delivery truck embodiment (Figure 1), console 20 may optionally be equipped to show whether truck 10 moved during delivery by printing a ticket 21 showing the odometer reading at the beginning and at the end of each delivery. If this option is desired, an electric pulser 536 is installed on the truck odometer. Pulser 536 transmits pulses, each representing a certain incremental distance traveled, along line 538 to odometer analog/digital converter block 540 and thence to odometer interface 542. Interface 542 is connected via paths 544, 546 to data and address buses 456, 458.

Referring to Figure 11, portable RAM card 180, designed to dump data pertinent to each day's delivery route to CPU unit 472 and record delivery data for processing by the mainframe computer thereafter, is connected to RAM card interface block 548 by data and address paths 550, 552. Interface block 548 is in turn connected to data and address buses 456, 458 (Figure 10) via paths 554, 556.

As discussed below, the volume delivered may optionally be corrected to a standard volume at a given temperature for correct pricing. To determine the correction factor between "gross volume" (volume at the ambient delivery temperature) and "net volume" (volume at a given temperature, conveniently 60°F.) the average temperature of the fluid needs to be obtained. To obtain the average temperature, resistance temperature probe 558 samples the temperature at frequent periodic intervals, such as twice per second, each sampled temperature corresponding to a volumetric increment. The sampled temperatures are encoded into serial format, e.g., RS232 format, by serializer 560, and transmitted via serial channel 561 to DART 158.

DART 158 also outputs serial printer data via channel 562 to printer serial interface block 516. Receiving printing commands via printer data and address buses 564, 566 from printer CPU block 510 in connection with printer ROM 568 and printer RAM 570, interface block 516 outputs instructions to the printer head solenoids 572 via path 574 and trigger line 578 and to motor speed block 514 via line 584, and receives a signal from dot position sensor 580 via line 582.

Dot position sensor block 580 senses the position of dots as printed by the dot-matrix printer head by optically coupled LED 586 and photo-transistor 588, and relays this information to motor speed block 514 via line 590.

Motor speed block 514 controls the motion of Printer motor 592, whose feeds are connected across diode 593. Motor speed block 514 allows the ticket to advance in ticket tray 166 (Figure 5) only after an entire line has been printed.

DART unit 158 also receives signal line 594 from ticket sensor 168. Sensor 168 has an LED 596 optically coupled to a photo-transistor 598, and is able to sense the presence or absence of a ticket between these two components. DART unit 158 is connected to CPU unit 472 via digital data and address paths 600 and 602.

Referring back to Figure 10, the remaining interface component, interface block 604, is connected to CPU data and address buses 456, 458 via paths 606, 608. Interface block 604 handles digital data from keyboard assembly 76, display assembly 74 and a signal from truck ignition 610 through path 612, path 614 and line 616, respectively.

User procedure

In the preferred embodiment, console 20 is designed to operate in up to eleven different modes, with each mode using different inputs, employing different calculating algorithms and producing different outputs. The modes are designated as Mode 0 through Mode 9, with the eleventh mode being Mode "P".

The driver of truck 10 has access to Modes 0 and 1 without knowledge of any security code. Higher modes are protected with various levels of security, with Mode "P" - the measurment "prover" mode - being mose secure and bearing a governmental department of weights and measures seal.

The various modes and their security levels are set out in the following table.

TABLE 1

Console operating modes

Mode Number	Function	Security Level
0	menu	open
1	driver	open
2	dispatcher	keyed
3	supervisor	keyed
4	valve setup	keyed
5	enable/disable presets	keyed
6	real time clock	keyed
7	diagnostics	keyed
8	software identification	keyed
9	odometer calibration	keyed
P	prover mode	sealed

Mode 0

Figure 12 depicts the user flowchart for Mode 0. From start 200, the operator depresses the M# key 108 per step 202. In 204, display 74 comes back with "ENTER MODE NO." and "0". From this display there is a two-way branch via paths 208 and 210 depending on the mode selected.

Mode 1 is accessed via path 206. The operator simply depresses "M1" key 107 per 212 and arrives at Mode 1, 214. For further details of Mode 1, see Figure 13.

Where access to Modes 2, 3, 4, 5, 6 or 9 is desired, path 208 is used. In step 216, the operator depresses the digit key corresponding to the mode number *n*, and then ENTER key 105. In response, display 74 will prompt with "KEY" in step 218. The operator then enters a four digit number in step 220.

At decision 222, if the four digit number equals the code key K_n stored in memory for the mode for which access is desired, the console will allow access to mode *n* at 224. See Figure 15 for the user flowchart for Mode 2. If the entered number does not equal K_n, the console will dump the operator to Mode 1 (214) via path 226.

Modes 7 and 8, accessed by path 210, have no security feature. The operator presses digit key 96 or 97 ("7" or "8") and "ENTER" key 105, per input step 228. This causes him to enter either Mode 7 or 8, as shown by connector 230.

Mode 1

Turning now to Figure 13, the first portion of the operator procedure for Mode 1 is diagrammatically shown. In the delivery-truck embodiment of the invention (Figure 1), this mode is used by the driver when making deliveries of liquid product. The console modes will hereinafter be described as they apply to the liquid product vehicle delivery embodiment.

Mode 0 connector 232 indicates that Mode 1 may be accessed by the Mode 0 procedure (Figure 1). The display will first show "M1-DELIVERY MODE" (234). The operator then presses ENTER key 105 (input 236) to arrive at the NET VOLUME GALLONS display 238. This display can alternatively be reached by switching on truck ignition 610 (Figure 10) per step 239. Display 238 is the first display of a series of displays in the Mode 1 display cycle.

NET VOLUME GALLONS display 238 displays that message on top display row 81 and the volume of the product delivered in gallons as corrected to a base temperature on bottom display row 84 (See Figure 6). At the beginning of the delivery cycle, this is initialized to "0".

To leave NET VOLUME GALLONS display 238, the operator presses downscroll key 104 at 240 or upscroll key 103 at 241 (Figure 14). The operator may look at any of the following displays by successively pressing either of scroll keys 103, 104. If downscroll key 104 is depressed, GROSS VOLUME GALLONS display 242 will appear and will indicate the number of gallons of delivered product uncorrected for temperature. This value is also intialized to zero. The operator may now upscroll at 243 back to GROSS VOLUME GALLONS display at 238, or he may downscroll at 244 to arrive at TEMP THIS DEL *F display 246, which indicates the temperature of the liquid product as last sampled by temperature probe 558 (Figure 11). NET VOLUME GALLONS 238, GROSS VOLUME GALLONS 242 and TEMP THIS DEL *F 246 are displays which cannot be changed by the operator in Mode 1.

Downscrolling again at step 248 causes the console to display "PRODUCT NUMBER" at 250. If the operator decides to change the product number by following path 252, he presses CLEAR key 106 at 251 and enters the product code at 253, which will then appear on the display at 250. If the product number is correct, the operator may downscroll at 254 to ACCOUNT NUMBER display 256. If the operator decides to change the account number by following branch 258, he does so by clearing display 74 and entering the new number at 260. Looping back to display 256 via path 261, the operator has a chance to satisfy himself that the number is correct. Once so satisfied, he downscrolls or upscrolls at 262.

Upon upscrolling or downscrolling at 262, the console determines at 259 whether the account number entered at 260 matches any number on a list of account numbers stored in RAM block 460 (Figure 10). If it does and if the operator has downscrolled, INVENTORY display 263 will next appear. A matching account number plus an upscroll will access PRODUCT NUMBER display 250. If the account number is spurious, the routine loops back via path 264 to ACCOUNT NUMBER display 256, and will continue to do so unless a matching account number is entered.

The driver may also elect to change the number of gallons of inventory shown on display 263 by following path 266. If he does, he clears at 267 and enters the new data at step 268, and the inventory display 263 will then reflect the entry.

PRESET GROSS, PRESET NET and PRESET PRICE functions 274, 276 (Figure 14) and 282 (Figure 14) are available to be displayed and changed only if the functions have been enabled through Mode 5. PRESET GROSS allows a gross volume delivery limit to be set, whereby an automatic fluid shutoff sequence (later described) is triggered when a certain gross volume of delivered fluid is reached.

The preset gross volume may be changed by following branch 273, clearing at 272 and entering a new limit at 275.

Connectors 270, 269, 295 and 298 in Figure 13 match like numbered connectors in Figure 14, where the scroll cycle continues. Downscrolling at 278, the operator is able to view PRESET NET display 176 (Figure 14). This displays a net volume delivery limit which actuates the automatic shutoff sequence upon being approached. The preset net volume may be changed by following branch 277, clearing at 280 and entering a new preset net volume at input step 279.

By downscrolling at 315, the PRESET PRICE display 282 may be reached. This preset sets a limit on how many dollars' worth of a product may be delivered before actuating the automatic shutoff sequence. Following path 281, the Mode 1 operator may clear the display at 317 and enter a new dollar limit at 283.

As previously noted, any or all of the three presets (274 (Figure 13), 276, 282) may be disabled and may thus be unavailable to the Mode 1 operator to view or change. The scroll cycle would be correspondingly truncated, with scroll cycle paths 311, 313 being connected to paths 285 and 299 were all presets disabled or 289 and 300 were PRESET NET and PRESET PRICE disabled, or 293 and 301 were PRESET PRICE only disabled. Connectors 270, 269, 294 and 295 would be bypassed were PRESET NET and PRESET PRICE disabled. Connector 298 would show the correct user flowchart path were all three presets, or PRESET NET and PRESET PRICE alone, disabled. Alternate paths may be drawn were only, say, PRESET GROSS disabled, but their paths have been omitted from Figures 13 and 14 for clarity.

At this point, the operator may scroll up or scroll down at input steps 241, 319 to check the various parameters displayed in Mode 1, or he may enter the start sequence by pressing START key 102 at 284. If PRESET PRICE 282 and/or other presets are disabled, the operator uses alternate START path 265.

The console will then look for an inserted ticket at 286. If no ticket has been inserted, a REQUEST TICKET message is displayed at 287. The physical insertion of a ticket at 288 will loop the procedure back to decision point 286.

Once the ticket is inserted, the console next checks at decision point 290 to see if switch 494 (Figure 10) is in remote print position 502. The procedure will go no further until switch 494 is turned to RUN position 499 manually at step 291.

Once switch 494 is switched to RUN, the console checks the pump pressure at 292. If the pump pressure is incorrect, the operator manually changes it at step 297. Once the correct pump pressure has been set, path 306 is followed to delivery enable point 302, and the liquid product delivery begins.

If one of the three presets above mentioned applies to the particular customer, the procedure path will proceed from decision 304 to decision point 305, where the console compares the volume so far delivered to a preset volume V_P minus a dwell increment D. V_P is calculated as the least of (1) V_g, preset gross volume; (2) V_{ng}, preset net volume modified by a temperature correction factor to a gross volume; and (3)V_{sg}, equivalent to

$$\frac{S}{P(a(T_n - T_g) + 1)}$$

where S = total price limit, P = price per net gallon at a base temperature, a = temperature coefficient, T_n = base temperature, and T_g = average temperature at which the delivery is being made. If the delivered volume does not yet equal $V_P - D$, the liquid will continue to be delivered to the customer at the normal rate, and logic path 321 will cycle back to decision point 305 to be tested at the next time increment. If the delivered volume equals $V_P - D$, the console will send a "dwell" command to dwell solenoid 484 (Figure 10), greatly reducing flow rate through the associated delivery valve. Dwell state 308 will be maintained as long as the delivered volume is less than V_P, a comparison done at step 309. When V_P is finally reached, the console sends a signal to shutoff solenoid 482 (Figure 10) to shut off the delivery valve per instruction 310, which in turn enables delivery ticket 21 (Figure 1) to be printed at step 312.

Where none of the three presets has been specified, the delivery is ended manually per manual dwell step 314 and manual shutoff step 316. The operator then either depresses PRINT key 101 at step 318 or turns switch 494 to remote print position 502 at 323 to enable ticket-printing step 312. The printing of the ticket ends the Mode 1 cycle.

The information printed on a ticket generated by Mode 1 varies with the software instructions encoded into the ROM 466 of CPU unit 472 (Figure 10). In this embodiment, the following items may be listed:

1. Date and time of start of delivery
2. Date and time of end of delivery
3. Truck odometer reading at start of deliver
4. Truck odometer reading at end of delivery
5. Odometer reading change during delivery
6. Ticket number
7. Sale number
8. Unit (console) identification number
9. Operator number
10. Truck number
11. Net or gross volume gallons at start
12. Net or gross volume gallons at finish
13. Temperature this delivery, °F
14. Product number
15. Total, tax category 1
16. Total, tax category 2
17. Total, tax category 3
18. Total, tax category 4
19. Tax this delivery
20. Price/unit, no tax
21. Price including tax

If any of the above items is zero, it will not be printed.

Mode 2

Figure 15 shows a user flowchart for Mode 2 operation. From Mode 0 (connector 320), the operator knows he has accessed Mode 2 by the "**M2– PRICE AND TAX**" display 322. He then presses ENTER at step 324 to arrive at the first display 326 of the Mode 2 scroll cycle. In one embodiment, the items successively displayed in the Mode 2 scroll cycle occur in the following order:

1. PRODUCT NUMBER
2. PRICE/UNIT NO TAX
3. TAX/UNIT CAT 1
4. TAX/UNIT CAT 2
5. TAX/UNIT CAT 3
6. TAX/UNIT CAT 4
7. % TAX CAT 1
8. % TAX CAT 2
9. % TAX CAT 3
10. % TAX CAT 4
11. OPERATOR NUMBER

Where the above order is adopted, ITEM 1 display 326 becomes the PRODUCT NUMBER display, ITEM 2 display 328 becomes the PRICE/UNIT NO TAX display, and the ITEM *n* display 330 becomes the OPERATOR NUMBER display. The operator may move from any one Mode 2 display to any other Mode 2 display by the operation of downscroll key 104 and upscroll key 103 at downscroll steps 332 and upscroll steps 334. When the change of any of the above items is desired, the operator clears the display at one of the CLEAR steps 336, and enters new data at the associated data entry step 338. Entry of the data will cause the associated item display to display the new data.

The Mode 2 display sequence shows, for each product identified by a product number, a price per volumetric unit and several tax parameters. This is desirable because truck-delivered liquids and in particular petroleum products such as fuel oil and diesel fuel, are subjected to different sales taxes based upon 1) the jurisdiction, 2) the tax categrory of the recipient, 3) the use or uses of the product and 4) the amount delivered. Taxes may vary from county to county, may not be applicable to non-profit or religious organizations, or may be applicable at a lesser rate. Furthermore, the tax rate may vary within certain volume categories. Finally, the tax structure may differ between fuel uses, e.g., fuel used for residential heating v. diesel fuel for vehicles. Console 20 is thus programmed in this embodiment to store and use at least four different tax categories for each product, both by tax per volumetric unit and by tax per dollar amount sold.

Mode 2 also registers which operator is using which supervisory console or truck.

The Mode 2 scroll sequence may be exited by pressing an exit key at 340. Alternatively, the operator may choose to print a Mode 2 ticket by depressing PRINT key 101 at step 342 to generate a ticket at 344. Figure 15 shows a dotted path 345 to the PRINT sequence from ITEM n display 330, as the PRINT sequence may be actuated from any Mode 2 display. A Mode 2 ticket prints our any or several of the following items:

1. Truck number
2. Unit ID number
3. Last sale number
4. Last ticket number
5. Total net volume
6. Total gross volume
7. Cumulative tax category 1
8. Cumulative tax category 2
9. Cumulative tax category 3
10. Cumulative tax category 4

As can be seen from the above items, a Mode 2 ticket 344 is designed to be printed out at the end of a work shift to maintain a record of deliveries. Totals of sales in the various tax categories and total net and gross volumes are displayed after a certain sale and/or ticket number, for the amounts delivered since a last Mode 2 ticket was printed.

Mode 3 - Supervisor Mode

This mode is accessed in a manner similar to Mode 2. The following displays can be read and changed, in accordance with the Mode 2 procedure:

1. Sale number
2. Ticket number
3. Total net volume
4. Total gross volume
5. Cumulative tax category 1
6. Cumulative tax category 2
7. Cumulative tax category 3
8. Cumulative tax category 4
9. Total tax
10. Total sales, no tax
11. Total sales, incl. tax
12. Total gross volume not priced
13. Total net volume not priced
14. One-time key for Mode 2
15. Key for Mode 2
16. Key for Mode 3
17. Key for Mode 4
18. Key for Mode 5
19. Key for Mode 6
20. Key for Mode 9
21. Number of decimal places, volume
22. Number of decimal places, price
23. Maximum price/unit, including tax

In the above list, items 1 and 2 (sale number and ticket number) are records of the sequential numbers of the last ticket and last sale processed by console 20. Items 3 through 11 are cumulative totals for the console, and normally would not be changed except after installing or moving a meter or register. Items 12 and 13 are records of liquid delivered where no price was charged, and are thus a further precaution against theft.

Items 14 through 20 contain the entry keys for Modes 2-6 and Mode 9. The keys for these modes may therefore be changed in the field at any time by a person entrusted with the last Mode 3 key. Item 23, the "maximum price/unit including tax" figure, assigns an upper limit to what customers are charged for delivered products. If a mistake is made in pricing a product in Mode 2 such that the entered price/unit exceeds the maximum, an error message will be generated.

A ticket may be printed in Mode 3 at any time by pressing PRINT key 101. The ticket may be set up to show any of the following items:

1. Truck number
2. Unit identification number
3. Sale number
4. Total net volume
5. Total gross volume
6. Cumulative tax category 1
7. Cumulative tax category 2
8. Cumulative tax category 3
9. Cumulative tax category 4
10. Total tax
11. Total sales, no tax
12. Total sales, including tax
13. Total net volume not priced

It is contemplated that a ticket will be printed before and after any changes in the program are made.

Mode 4 - Valve setup

This mode is accessed from Mode 0 by use of a key, and uses display/change procedures similar to those of Mode 2 (see Figure 15). Mode 4 access is acknowledged by the display **M4--VALVE RELATED**. The following displays are shown and may be changed:

1. First stage closure
2. Dwell flow (units/min)

The first display concerns for how much volume* the delivery valve will be partially open in a DWELL condition, i.e., as the delivered volume nears a preset volume, when the flow rate will be cut down to minimize hydraulic shock. The second display sets the dwell flow rate.

Mode 5 - Enable/disable presets

Mode 5 is accessed through Mode 0 by use of a key. Access is acknowledged by the display "**M5--ENABLES**". Mode 5 allows the display and change of the following items in a manner similar to Mode 2:

1. Enable net preset
2. Enable gross preset
3. Enable price preset

Setting any of items 1-3 to "1" will enable the particular preset, i.e., the operator may set the preset in Mode 1. Setting of any of items 1-3 to "0" will disable the preset, making that preset function unavailable to a Mode 1 operator. For details as to each preset, refer to the discussion of presets under *Mode 1*.

Mode 6 - Real time clock

Mode 6 is accessed through Mode 0 by use of a numeric key. Access is acknowledged by the display **M6--REAL TIME CLOCK**. Mode 6 allows the display of the following items:

1. Year
2. Month
3. Day
4. Hour
5. Minutes
6. Seconds
7. Date-time group

Items 1-6 may be displayed and changed in a manner similar to Mode 2 in order to set the console's built-in real time clock. "Date-time group" may not be changed.

Mode 7 - Diagnostics

Mode 7 is accessed through Mode 0 without the use of a numeric key. It allows the display of the following items:

1. Before rounding
2. After rounding
3. Places to round to
4. Actual probe temperature, °F
5. Temperature coefficient
6. Pulses/unit volume
7. Odometer pulses/mile
8. Trip odometer
9. Total miles

Of the above items, only "before rounding" and "places to round to" may be changed in Mode 7 as affecting the rounding function of the console. Items 4-9 are Prover Mode (Mode P) data which may be checked but not changed in Mode 7.

Mode 8 - Software identification

Mode 8 is accessed through Mode 0 but requires no key. Access is acknowledged by the display "**M8–IDENTIFICATION**". The following displays may be viewed but not changed:

1. Software version and date
2. Hardware model no.
3. Console order no.
4. Meter order no.
5. Total counts/1000

Item 5, "total counts/1000", represents a cumulative total of the meter pulses registered on the console, divided by 1000. All five items may be printed on a ticket in Mode 8, which is actuated by pressing PRINT eky 101.

Mode 9 - Odometer calibration

Mode 9 is accessed through Mode 0 by use of a numeric key. Access is acknowledged by the display "**M9–ODOMETER**". The following items in Mode 9 may be displayed and changed in a manner similar to the Mode 2 procedure:

1. Trip Odometer
2. Total miles
3. Pulses/mile

Item 3, pulses/mile, allows calibration of the conversion factor between odometer pulses sensed by analog/digital converter 540 (Figure 10) and actual miles travelled.

Mode P - Prover mode

Since the apparatus of the invention is involved in the delivery of taxed and regulated commodities, the accuracy of the meter's measurement may have to be approved by a governmental authority. Access to Mode P allows the calibration of volumetric and temperature measurement.

Figure 16 shows a user flowchart for Mode P. Unlike Modes 1-9, access is not obtained though Mode 0. The operator must first break a Department of Weights and Measures seal 46 (Figures 7 and 8) at step 350, open the prover mode switch seal plate 120 at step 352, and flip prover switch 128 at step 354. The console will then look for an initial ticket at 356. If a ticket has not been inserted, it will display REQUEST TICKET at 358 until a ticket is inserted. It will then print the following information at step 360:

1. Unit identification number
2. Base temperature
3. Temperature coefficient
4. Gross volume, gal.
5. Net volume, gal.
6. Temperature offset
7. Temperature this delivery
8. Total counts/1000
9. Meter factor
10. Pulses per unit volume

Once the initial ticket has been printed, the console will ask for a new ticket at 362 and verify that the ticket has been inserted at 364. After the second ticket has been inserted, Mode P will proceed to a scroll cycle, the first display of which is BASE TEMPERATURE display 366. The base temperature is the one for which the "net volume" of the product is calculated. If, for example, the base temperature is 60°F, and the average delivery temperature is 40°F, the "gross volume" delivered at 40°F will be converted by the console to an equivalent net volume at 60°F. If it is desired to change the base temperature, the operator does so by executing CLEAR step 368 and data entry step 370.

Scrolling down by pressing downscroll key 104 at 372, the operator next views TEMP COEFFICIENT display 374. This display displays the value for *a*, used in the volume conversion calculation step

$$V_n = V_g\,(a(T_n - T_g) + 1)$$

where V_n = net volume, V_g = gross volume, T_g = average delivery temperature (°F) and T_n = base temperature (°F). Temperature coefficient *a* may be changed by executing CLEAR step 376 and data entry step 378.

The operator is now ready to calibrate the meter. By pressing START key 102 at 380, delivery is enabled at 382. The liquid flows through both meter 18 of the truck and also a master meter. The master meter records a correct gross volume at 384 after a selected amount of liquid has been run through.

After completion of the prover run and associated manual shutoff sequence at 385, the operator next downscrolls at 386 on console 20 to arrive at GROSS VOLUME GALLONS display 388. Console 20 will meanwhile have counted the pulses received from meter 18 at 389 and will have calculated a gross volume therefrom at 390. The display will therefore show the gross volume measured by the console in the prover run. In the circumstance that the indicated gross volume is different from that measured by the master meter, the operator clears the display at 391 and enters the master meter gross volume (V_{gm}) at 392.

At step 398, the console back-calculates the number of pulses per unit of gross volume from V_{gm} entered at 392. The console also calculates the net volume at 400 with the aid of temperature coefficient a entered at step 378, the base temperature T_n entered at 370 and the average delivery temperature T_g. The various Mode 9 displays 402 are then altered by the console, where applicable, to reflect the new calibration. The Mode 9 displays are listed below in their scroll order in this embodiment:

1. BASE TEMPERATURE
2. TEMP COEFFICIENT
3. GROSS VOLUME GALLONS
4. NET VOLUME GALLONS
5. TEMP OFFSET-DEG F
6. TEMP THIS DEL F
7. UNIT ID NUMBER
8. TRUCK NUMBER
9. PULSES/UNIT VOLUME

Each of these displays may be changed in a manner similar to that used in Mode 2, except for the TEMP OFFSET display which is calculated automatically.

After all changes have been calculated/entered, the operator presses PRINT key 101 at 404 to generate a ticket similar to that printed before the prover run at 360. The operator will then have a written record of the current calibration parameters.

While the foregoing description of certain preferred embodiments illustrates the invention, the invention should not be construed as being limited to those embodiments but rather by the scope of the claims which follow.

CLAIMS

1. A method of delivering and accounting for liquid products, comprising the following steps:
(a) connecting a portable information capsule to main computer means;
(b) transmitting from the main computer means into the portable information capsule information concerning planned individual deliveries;
(c) disconnecting the portable information capsule from the main computer means, carrying the portable information capsule to a vehicle loaded with liquid products, the vehicle including calculator means, and connecting the portable information capsule to the calculator means;
(d) transmitting the planned individual delivery information to the calculator means from the capsule, the calculator means including memory means receiving the planned individual delivery information;
(e) driving the vehicle to at least one delivery location;
(f) connecting at least one liquid product delivery line on the vehicle to at least one customer product delivery point, which fuel delivery line includes a volumetric meter;
(g) inserting a ticket into ticket printing means;
(h) starting liquid product delivery;
(i) measuring the liquid product being delivered using the volumetric meter-
(j) transmitting the measure of product delivered to the calculator means;
(k) storing the measure of the product delivered in the memory means;
(l) stopping the liquid product delivery and transmitting to the calculator means a signal indicating that delivery has stopped;
(m) calculating the total volume of product delivered, the price of the delivered product, and the date and time before and after delivery using the planned individual delivery information;
(n) transmitting to and storing in the portable information capsule information relating to the actual delivery;
(o) printing a ticket, which ticket sets forth planned and actual delivery information; and
(p) subsequently retrieving the portable information capsule, connecting the capsule to the main computer means, and transmitting actual delivery information to the main computer means.

2. The method of Claim 1, further comprising the steps of
(a) measuring at discrete intervals the temperature of said liquid product as it is being delivered;
(b) transmitting the measures of temperature to said calculator means; and
(c) calculating a delivered volume as corrected to a standard temperature.

3. The method of Claim 1, wherein said planned individual delivery information includes information concerning taxes for each delivery, which taxes may be applicable at a flat rate or at a sliding scale as a function of delivered volume, the calculator means calculating a tax on the delivered liquid product, said ticket printing means printing the tax on the ticket, the tax being stored as actual delivery information in said portable information capsule.

4. The method of Claim 1, wherein the step of stopping said product delivery is actuated by the calculator means, the calculator means comparing actual delivered volume to a stored volume amount.

5. The method of Claim 4, wherein the step of stopping said product delivery is preceded by a step of slowing down the rate of product delivery, each step being actuated by said calculator means.

6. The method of Claim 4, wherein the stored volume amount is calculated from a price limit on said delivery.

7. The method of Claim 4, wherein the stored volume amount is calculated from an equivalent volume at a standard temperature.

8. The method of Claim 1 further comprising the steps of

(a) storing at least one customer account number, the account number being transmitted from said portable information capsule to said memory means;

(b) entering a second account number into the calculator means,

(c) comparing the second account number to at least one stored account number, the calculator means disabling delivery unless the second account number equals at least one stored account number.

9. The method of Claim 1 wherein information stored in said memory means, including price information, tax information, cumulative totals of amounts of products delivered, real time, and measurement calibration parameters, are accessible and changeable by an operator through said calculator means, but only after a sealed switch means has been unsealed and switched in the case of the measurement calibration parameters, and only after an alpha-numeric code enabling access has been correctly entered into the calculator means in the case of other stored information.

10. The method of Claim 1 further comprising the steps of

(a) storing a first odometer reading of said vehicle before said liquid product delivery is started,

(b) storing a second odometer reading of said vehicle after said liquid product delivery is stopped, and

(c) transmitting the first and second readings to said portable information capsule as actual delivery information, and causing said ticket printing means to print the first and second readings on said ticket.

11. The method of Claim 1 wherein

the step of starting liquid product delivery cannot be undertaken until said ticket is inserted into said ticket-printing means.

12. A method of loading liquid products onto a vehicle, comprising the following steps:

(a) connecting portable identification means to calculator means;

(b) transmitting identification information from the portable identification means to the calculator means, which information is stored in memory means;

(c) connecting at least one liquid product delivery line to a vehicle;

(d) inserting a ticket into ticket printing means, which ticket printing means is controlled by the calculator means;

(e) starting liquid product delivery to the vehicle;

(f) measuring the liquid product being delivered using a volumetric meter in the delivery line;

(g) transmitting the volumetric measurement of the delivered product to the calculator means;

(h) storing said volumetric measurement in the memory means;

(i) stopping liquid product delivery and transmitting to the calculator means a signal that delivery has stopped;

(j) calculating the total volume of product delivered, the price of the delivered product, and the data and time at the starting and stopping of liquid product delivery to the vehicle, using product information supplied to the memory means by main computer means;

(k) transmitting to the main computer means information relating to the actual delivery and the identification information; and

(l) printing a ticket, which ticket sets forth identification information, product information and actual delivery information.

13. The method of Claim 12, further comprising the steps of

(a) measuring at discrete intervals the temperature of said liquid product as it is being delivered;

(b) transmitting the measures of temperature to said calculator means; and

(c) calculating an equivalent delivered volume as corrected to a standard temperature.

14. The method of Claim 12, wherein said product information includes information relating to taxes, which taxes may be applicable at a flat rate or at a sliding scale as a function of delivered volume, the calculator means calculating at least one tax on the delivered liquid product, said printing means printing the tax on the ticket, the tax forming a portion of actual delivery information transmitted to said main computer means.

15. The method of Claim 12, wherein the step of stopping said product delivery is actuated by said calculator means, the calculator means comparing actual delivered volume to a stored volume amount.

16. The method of Claim 15, wherein said step of stopping said product delivery is preceded by a step of slowing down the rate of product delivery, said steps being actuated by said calculator means.

17. The method of Claim 16, wherein said stored volume amount is calculated from an equivalent volume amount at a standard temperature.

18. The method of Claim 16, wherein said stored volume amount is calculated from a price limit on said delivery.

19. The method of Claim 12 further comprising the steps of

(a) transmitting at least one delivery account number from said main computer means to said memory means, where it is stored;

(b) transmitting a second delivery account number from said portable identification means to said calculator means;

(c) causing said calculator means to compare the second delivery account member to at least one stored account number, the calculator means disabling delivery if the second account number does not equal at least one stored account number.

20. The method of Claim 12 wherein information stored in said memory means, including price information, tax information, cumulative totals of amounts of products delivered, real time and measurement calibration parameters, are accessible and changeable by an operator through said calculator means, but only after a sealed switch means has been unsealed and switched in the case of the measurement calibration parameters, and only after a correct alphanumeric code enabling access has been entered into the calculator means in the case of other information stored in the memory means.

21. The method of Claim 12 wherein the step of starting liquid product delivery cannot be undertaken until said ticket is inserted into said ticket-printing means.

22. A method of delivering and accounting for liquid products using a delivery vehicle, comprising the following steps:

(a) providing a calculator means as mounted on a liquid product delivery vehicle, the calculator means having associated ticket printing means, memory means, manual entry means and display means, the memory means being preprogrammed with calculating programs, constants including volumetric calibration parameters, and a real time clock;

(b) connecting a portable electronic memory information capsule to main computer means;

(c) transmitting from the main computer means to the capsule, and storing in the capsule, planned individual delivery information for a plurality of deliveries, the planned individual delivery information including customer account numbers, customer names and addresses, and customer price and tax rates;

(d) disconnecting the capsule from the main computer means, carrying the capsule to the vehicle as loaded with at least one liquid product, and connecting the capsule to the calculator means;

(e) transmitting the planned individual delivery information from the capsule to the memory means;

(f) printing a delivery route ticket incorporating planned delivery information;

(g) moving the vehicle to a first delivery location;

(h) connecting at least one liquid product delivery line from the vehicle to at least one customer product delivery point, each product delivery line having a volumetric meter, the volumetric meter having processor means which converts mechanical movement to electrical signals, the signals being sent to the calculator means;

(i) displaying and optionally altering by use of said manual entry means preprogrammed constants and planned individual delivery information, some of which constants and information require a previous correct manual entry of an alphanumeric code before said constants and information may be changed;

(j) manually entering a further account number intended to identify the first delivery customer, which account number is compared with the preplanned delivery information account numbers by the calculator means, the calculator means disabling product delivery if the further account number does not equal a preplanned delivery information account number;

(k) inserting a ticket into the ticket printing means, the calculator means sensing the presence or absence of the ticket in the ticket printing means, the calculator means disabling product delivery if a ticket has not been inserted;

(l) sensing liquid product pump pressure by the calculator means, the calculator means disabling delivery if the pump pressure is not within a specified range of pressures;

(m) starting liquid product delivery;

(n) measuring each liquid product being delivered using the volumetric meter, the meter processor means sending corresponding signals to the calculator means, each signal representing a volumetric increment of measure liquid;

(o) counting the number of signals by means of the calculator means, the calculator means converting the number of signals to a measurement of a total volume of delivered fluid;

(p) initiating a stop cycle when the desired amount of delivered liquid is approached, the calculator means slowing down the rate of liquid delivery by partially closing a meter valve for a specified length of time stored in the memory means;

(q) stopping the liquid delivery, the meter processor means sending a signal to the calculator means when liquid delivery is stopped;

(r) upon receipt of the stop signal by the calculator means, calculating the price and applicable tax for each delivered product, calculating the date and time at the start and at the end of the delivery, incrementing volume, dollar and tax totals for the delivery route and like totals for the history of the calculator means, the calculations using preprogrammed programs and constants and preplanned delivery information and resulting in actual delivery information;

(s) transmitting to and storing in the capsule actual delivery information;

(t) causing the printing means to print a ticket setting forth planned and actual delivery information;

(u) disconnecting at least one delivery line from at least one customer delivery point;

(v) repeating steps (g) through (u) for the remaining number of scheduled deliveries;

(w) printing a ticket at the end of the delivery route showing printed totals for the route; and

(x) retrieving the capsule, connecting the capsule to the main computer means and transmitting actual delivery information to the main computer means.

23. The method of Claim 22 further comprising the steps of;

(a) measuring at periodic intervals the temperature of each liquid product as it is being delivered;

(b) transmitting signals corresponding to the temperature measurements to said calculator means;

(c) storing the temperature measurements in said memory means;

(d) after receipt of said stop signal, calculating an average temperature of each said delivered product using the temperature measurements;

(e) converting said total volume of delivered product into an equivalent standard total volume of delivered product using the average temperature, a preprogrammed constant base temperature and a preprogrammed constant product temperature conversion factor,

(f) calculating dollar and tax amounts based on the equivalent total volume; and

(g) incrementing equivalent volume totals for the route and the history of the calculator means, the calculations and incremented totals resulting in actual delivery information.

24. The method of Claim 22, wherein the step of initiating the stop cycle is implemented by said calculator means, the calculator means comparing the volume of each delivered product to a corresponding preset delivered volume amount, the calculator means initiating the stop cycle when the preset delivered volume amount minus a dwell volume equals the volume of delivered product.

25. The method of Claim 24, wherein said preset delivered volume amount is calculated by said calculator means from a preset price limit.

26. The method of Claim 24, wherein said preset delivered volume amount is calculated from an equivalent volume amount at a standard temperature.

27. The method of Claim 22, further comprising the steps of

(a) counting by means of said calculator means each odometer pulse received from a pulsing odometer installed in said vehicle, each odometer pulse representing an increment of travelled distance;

(b) summing the total number of odometer pulses as received before the start of each delivery, and converting the sum to a first odometer reading;

(c) summing the total number of odometer pulses as received prior to said stop signal and converting the sum to a second odometer reading; and

(d) transmitting the first and second odometer readings as actual delivery information to said capsule.

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